DEC STD 119-2 Digital Product Safety - Test Procedures

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ABSTRACT: This document presents general information about test procedures required to determine that products meet design criteria of DEC STD 119-1, and it lists the detailed Test Methods that define the procedures to perform a specific test.

APPLICABILITY: This standard applies to all products tested per DEC STD 119-0 Digital Product Safety - Introduction and General Requirements and DEC STD 119-1 Digital Product Safety - Design Criteria. For markets and products that are not specifically addressed in this document, such as software or furnishings, the general principles of safety within IEC 950, Safety of Information Technology Equipment Including Electrical Business Equipment shall apply.

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1 REQUIREMENTS

Final product approval to the requirements of *DEC STD 119-1 Digital Product Safety - Design Criteria* requires the following.

a. Testing to the requirements of this document

b. Testing at a facility acceptable to the Product Safety engineer

A list of approved Product Safety Test Facilities is contained in EL-00424-00, *Digital Product Safety Handbook*.

Many of the tests required by this standard are inherently hazardous. Adequate safeguards for personnel and property shall be employed when conducting these tests.

The test methods in this document are typical procedures and may vary between test labs. Equivalent equipment and fixtures may be used for testing if the results are ensure compliance with the standard.

2 TEST PROCEDURES

2.1 TEST SAMPLE

Unless otherwise specified, the tests in this standard are type tests that shall be made on a single sample that shall withstand all the relevant tests. Additional samples or components may be required for destructive testing. Because of the expense of samples, discussion of the test program with Engineering Product Safety is advised.

As an alternative to carrying out tests on the complete equipment, tests may be carried out separately on components and subassemblies, provided that inspection of the equipment and circuit arrangements indicate that such tests will ensure that the assembled equipment conforms with this standard.

When a destructive test must be employed to evaluate the safety of the product, a model representing the condition to be evaluated may be used. Equipment for which optional features are offered shall be tested with those features that give the most unfavorable results, or a suitable simulation of those features.

Equipment containing safety extra-low voltage (SELV) circuits shall be tested with the designated supply device or equivalent. SELV tests must be repeated in the end product if testing with equivalent circuits yield results that may affect the safety of the product.

2.2 TEST CONDITIONS

Except where specific test conditions are stated elsewhere in this standard, tests shall be carried out under the most unfavorable combination of the following conditions within the operating specifications of either Digital's Product Specification or Digital's Purchase Specification, whichever is appropriate.

a. Supply voltage

b. Supply frequency

c. Physical location of equipment and position of movable parts

d. Operating conditions

2.3 POWER SOURCE

In determining the most unfavorable supply voltage(s) for a test, the following variables shall be considered.

a. The operating voltage range relevant to the rated nominal voltages appearing on the product nameplate. These figures appear in *DEC STD 122-0 AC Power Line Standard: Design Requirements and Guidelines* and in the Digital Product Specification.

b. Specific voltage test points required by test agencies.

Refer to the specific test methods for the operating voltage test points associated with that test. The possible influence of polarity shall be considered when testing subassemblies, components, and so forth, that are designed for dc only.

Test equipment characteristics and test procedures for testing ac power line parameters shall be as specified in *DEC STD 122-1 AC Power Line Standard–Measurement of AC Power Parameters*.

NOTE

When an autotransformer is specified in a procedure (typically 20 amp capacity), larger capacity models may be substituted, but not smaller.

2.4 FREQUENCY SELECTION

Equipment shall be subjected to testing while connected to a supply of rated frequency, except that equipment designed for operation at more than one frequency shall be tested at the frequency that will produce the worst case result.

In determining the most unfavorable supply frequency for a test, different nominal frequencies within the rated frequency range shall be considered (for example, 50 Hz and 60 Hz). Consideration of the tolerance on a rated frequency (for example, 50 Hz ± 0.5 Hz) is not required.

2.5 AMBIENT CONDITIONS

Where specified maximum temperatures and temperature rises are based on the assumption that the room ambient air temperature, when the equipment is in operation, is either Class A, Class B, or Class C according to *DEC STD 102-0 Environmental Standard for Computers and Peripherals - General Test Requirements*.

If the equipment, in its final application, is intended to be operated in a higher room ambient temperature, the limits of temperature rise shall be reduced accordingly so that maximum temperatures are not exceeded with the equipment operating at its maximum specified room ambient temperature. This may be checked by calculation if measurement at maximum ambient temperature is impractical. For equipment operating below 25°C, temperature rise limits shall not change and maximum temperatures shall be reduced accordingly.

Limits for maximum temperatures or maximum temperature rises are specified for compliance with certain tests, and the ambient room air temperature during these tests need not be controlled, but shall be monitored and recorded.

The classification of insulating material (Classes A, E, B, F, and H) is in accordance with IEC 85, *Recommendation for Classification of Materials for the Insulation of Electrical Machinery and Apparatus in Relation to Their Thermal Stability in Service*.

2.6 LOAD CONDITIONS

Unless stated otherwise, the equipment shall be tested at its specified load during normal operation. This load is specified within the Digital Product Specification or Digital Purchase Specification for the equipment, whichever is applicable.

2.7 CATEGORY OF TESTS

Testing can be divided into three subgroups:

Electrical Parameter Tests
Non-Operating Tests
Destructive/Stress Tests

2.8 TEST SEQUENCE

When performing equipment testing, finish all required testing for each subgroup before entering the next subgroup.

For electrical parameter testing, follow the stated sequence when conducting tests.

NOTE

- **Equipment starting and capacitor discharge require the unit to be at room ambient temperature.**
- **Temperature rise requires unit temperatures to be stabilized.**
- **Input rating, leakage current, and dielectric strength require the unit to be at a stable operating temperature.**

However, some of the tests may be performed at the component level and can be removed from the sequence.

2.9 TEST REPORT FORMS

Test reporting forms are provided for recording test results obtained by Digital Product Safety Lab Technicians for submission to the responsible Product Safety Engineer.

The tests are derived from the standards that appear in DEC STD 119-1. Each test description in this document lists the applicable clause(s) from these two documents.

The Product Safety Lab Technician shall enter the model number, serial number, revision level and other data pertaining to the equipment under test on the appropriate test reporting forms for submission to the Product Safety Engineer.

Product Safety Lab Technicians are responsible for documenting all results from tests performed.

The Test Report Forms may be duplicated, or use VTX SMC to order copies of EL-class documents from Standards and Methods Control.

3 119-TM-E1: TEST METHOD FOR LIMITED CURRENT CIRCUITS

PURPOSE

This test method is to insure that limited current circuits are designed not to exceed specified limits for current, shock, stored charge, or energy in the event of any basic insulation breakdown or a single component failure.

REQUIREMENT

This method tests for compliance to IEC 950 *Standard for Safety of Information Technology Equipment Including Electrical Business Equipment* requirements, clause 2.4 Limited Current Circuits.

TEST EQUIPMENT

- Tektronix 4623 or equivalent storage-type oscilloscope
- For clause 2.4.1, 2 kΩ ±1%, ¼ W metal film resistor
- For clause 2.4.2, 10 kΩ ±1%, ¼ W metal film resistor
- For clause 2.4.3, 150 kΩ ±1%, ¼ W metal film resistor
- For clause 2.4.4, 100 MΩ high voltage scope probe

TEST PROCEDURE

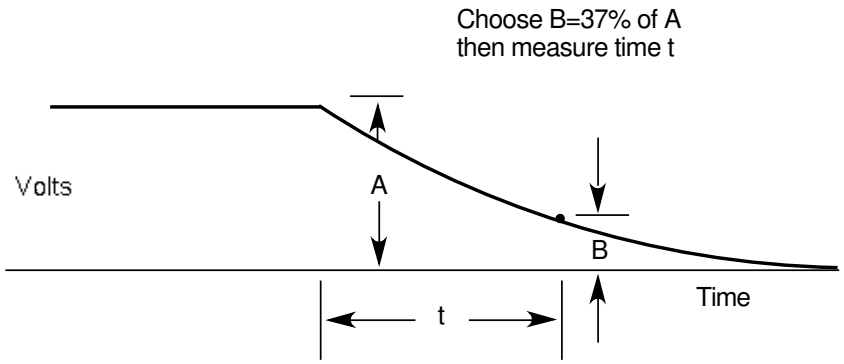
1. Measure the open circuit voltage and frequency if ac.
2. Use flow charts, Figures 2 and 3, to determine the next step.
3. For steady state sources, load with the 2 kΩ resistor and measure the voltage across the resistor.
4. For capacitive circuits, discharge the capacitor with the appropriate resistive load per the flow charts, Figures 2 and 3, and measure the time constant as shown by Figure 1.

NOTES

- **If internal circuit resistance is close to or less than the discharge resistance, it may be necessary to use a lower value discharge resistor, or to include this circuit resistance as part of the discharge resistance. Recalculate formulas using Figure 3.**
- **At higher voltages, the voltage rating should be considered when selecting resistors to avoid breakdown. Resistors in series may be needed.**

5. Calculate the required values using the formula in the flow charts in Figures 2 or 3.

Figure 1: Time Constant Decay Measurement



a. Repeat as necessary to obtain the curve shown in this figure, adjusting the scope's time base as required.
b. Measure the voltage from zero to Point A.
c. Multiply that voltage by 0.37. (0.37 = constant used to determine 1 time constant)
d. Find that voltage point further out on the curve, and record time t from A to B.

PASS/FAIL CRITERIA

Flow charts, Figures 2 or 3, illustrate pass or fail conditions for each test path.

Figure 2: Limited Current Circuit Test Flowchart—With Algebraic Formulas

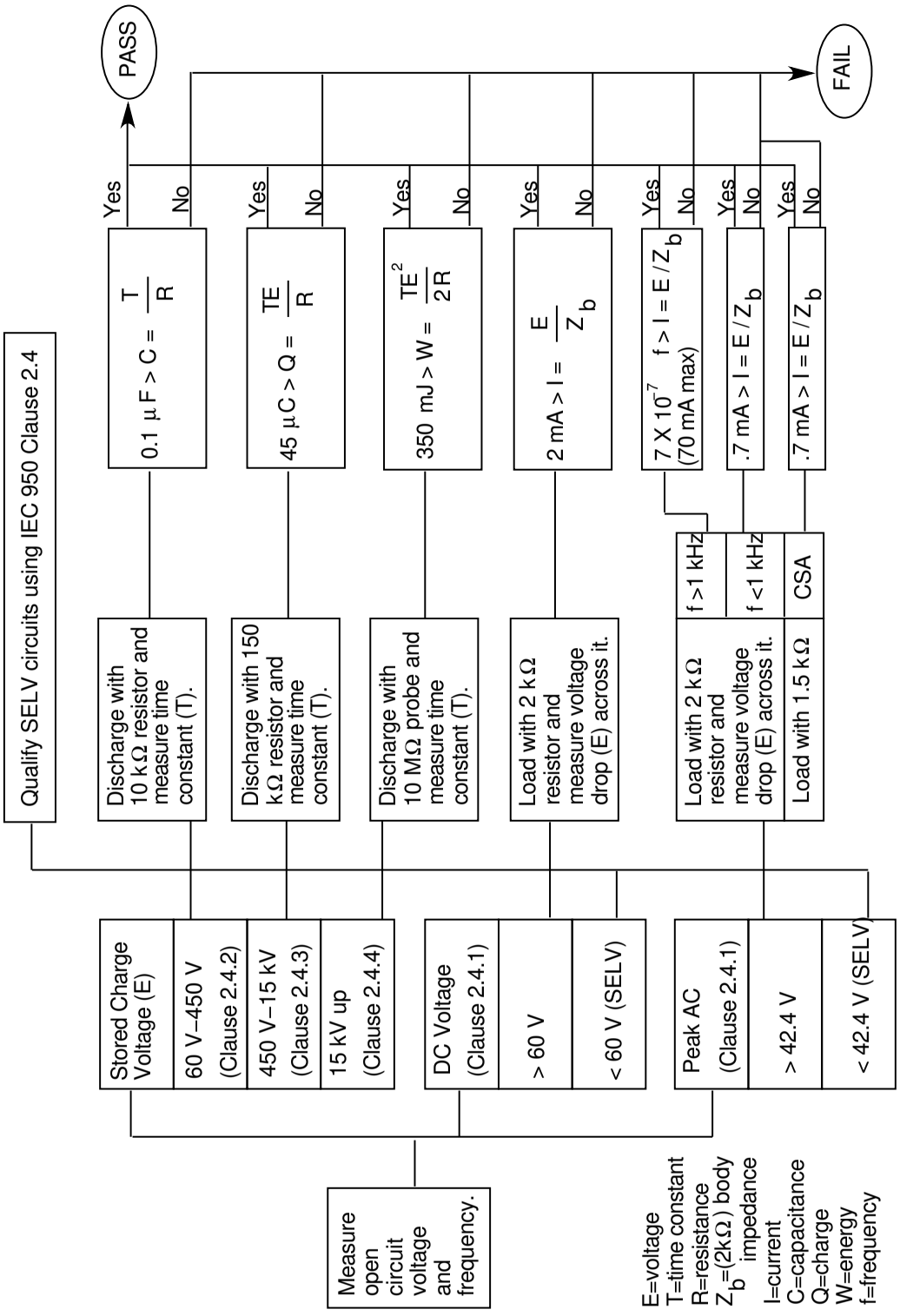
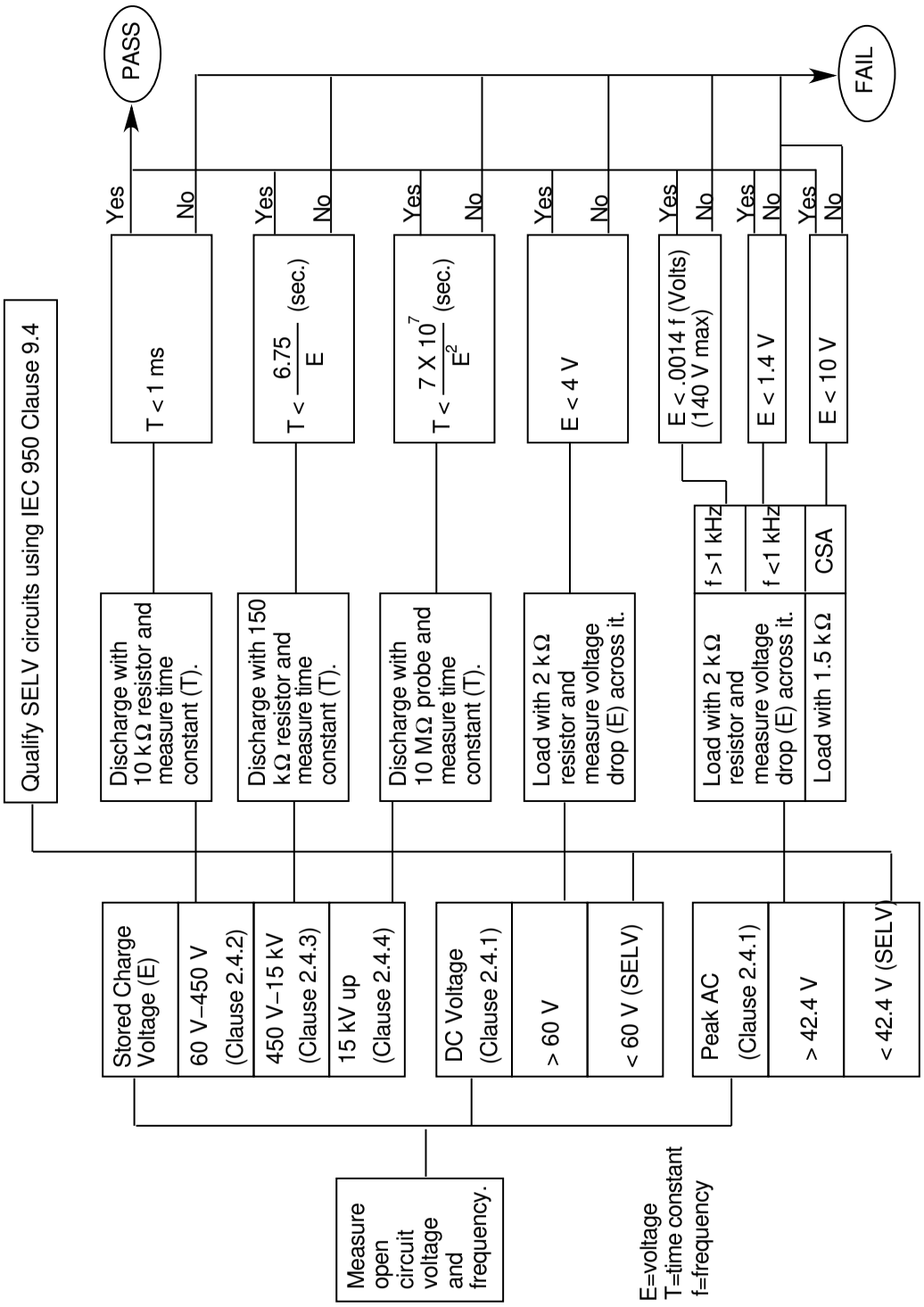

Qualify SELV circuits using IEC 950 Clause 2.4
Measure open circuit voltage and frequency.
Stored Charge Voltage (E)
60 V–450 V (Clause 2.4.2)
450 V–15 kV (Clause 2.4.3)
15 kV up (Clause 2.4.4)
DC Voltage (Clause 2.4.1)
> 60 V
< 60 V (SELV)
Peak AC (Clause 2.4.1)
> 42.4 V
< 42.4 V (SELV)
Discharge with 10 kΩ resistor and measure time constant (T).
Discharge with 150 kΩ resistor and measure time constant (T).
Discharge with 10 MΩ probe and measure time constant (T).
Load with 2 kΩ resistor and measure voltage drop (E) across it.
Load with 2 kΩ resistor and measure voltage drop (E) across it.
f >1 kHz
f <1 kHz
Load with 1.5 kΩ
CSA
0.1 μF > C = T/R
45 μC > Q = TE/R
350 mJ > W = TE²/2R
2 mA > I = E/Z_b
7 X 10⁻⁷ f > I = E / Z_b (70 mA max)
.7 mA > I = E / Z_b
.7 mA > I = E / Z_b
Yes
No
PASS
FAIL
E=voltage
T=time constant
R=resistance
Z_b=(2kΩ) body impedance
I=current
C=capacitance
Q=charge
W=energy
f=frequency

Figure 3: Limited Current Circuit Test Flowchart—With Numeric Formulas



4 119-TM-E2: TEST METHOD FOR STORED CHARGE (LINE CORD)

PURPOSE

This test method is to ensure there is no hazardous stored charge on the exposed pins of the line cord or appliance inlet or both for plug-connected equipment.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 2.1.10 Protection against electric shock and energy hazards.

TEST EQUIPMENT

- Autotransformer
- Tektronix 4623 or equivalent storage type oscilloscope
- Two each 100X scope probes (10-megohms impedance)

TEST PROCEDURE

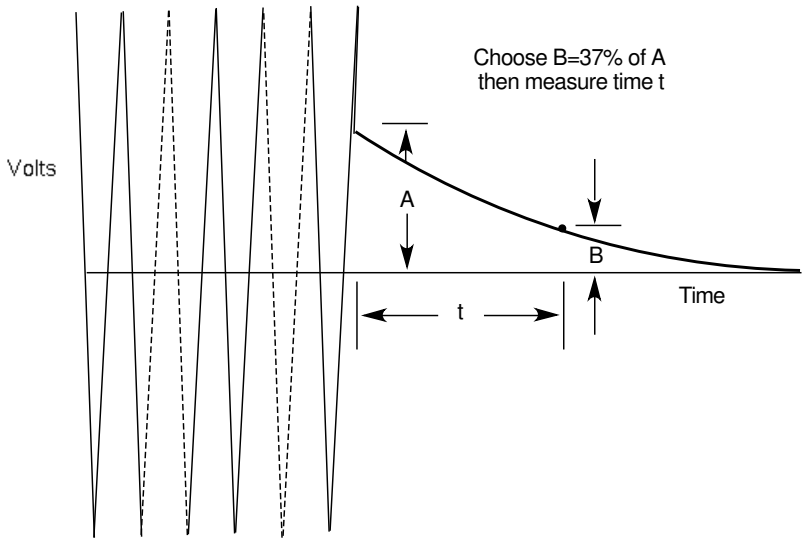
1. Connect 100X scope probes across phase and neutral conductors of the equipment under test.
2. Set the scope mode select to add channel 1 and channel 2; then invert channel 2. Connect channel 1 to one phase and channel 2 to neutral. Set volts per division to the same value for both channels.

NOTE

Do not use the ground clips on the scope probes.

3. Connect the voltage source to either a 50 Hz or 60 Hz frequency source, whichever is appropriate, then set the voltage source to the upper limit of the rated voltage range for the equipment under test.
4. Turn the equipment On/Off switch to On.
5. Set scope to STORAGE with time base at 0.1 second per cm. This setting may have to be changed to show the appropriate decay curve as shown in Figure 4.
6. Connect and then disconnect the equipment from the supply using the plug or a switch in the supply circuit.
7. Repeat step 6 as necessary to obtain the curve in Figure 4, adjusting the scope's time base as required and ensuring that the turn-off time at A occurs at a high enough voltage to ensure accurate measurements.
8. Measure the voltage from 0 to point A.
9. Multiply that voltage by 0.37. (0.37 = constant used to determine 1 time constant.)
10. Find that voltage point further out on the curve, and record time (t) from A to B.
11. Repeat steps 6 through 10 with the equipment On/Off switch in the Off position.
12. If the product has multiple voltage ranges, repeat steps 3 through 11 for the other upper voltage limit.

Figure 4: Time Constant Decay Curve



PASS/FAIL CRITERIA

The measured time constant (t) shall be less than one second for pluggable equipment type A, that is, products with household plugs like straight pin NEMA styles.

The measured time constant shall be less than 10 seconds for pluggable equipment type B, that is, products with industrial type plugs, such as IEC 309 or NEMA twist locks. (*IEC 309 Plugs, Socket Outlets, and Couplers for Individual Purposes*)

5 119-TM-E3: TEST METHOD FOR INTERLOCKED ACCESS

PURPOSE

This test method is to verify that a hazard is removed before contact with a test finger, and that inadvertent reactivation of the hazard cannot occur.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clauses 2.8.2 and 2.8.3.

TEST EQUIPMENT

- Autotransformer
- Tektronix 4623 or equivalent storage type oscilloscope
- Two each 100X scope probes (minimum 10-megohms impedance)
- IEC test finger

TEST PROCEDURE

Electrical and Energy Hazards

1. Connect the 100X probe across the plus and minus terminals of the hazard under test.
2. Set the scope mode select to add channel 1 and channel 2; then invert channel 2.

NOTE

Do not use the ground clips on the scope probes.

3. Connect the voltage source to either a 50 Hz or 60 Hz frequency source, whichever is appropriate; then set the voltage source to the proper voltage for the equipment under test per Table 1.

Table 1: Supply Voltage Test Points (Volts rms)

Nominal	Test Voltage
101	110
120	128
202	220
208	220
220	235
230	244
240	256
380	407
400	422
415	443

4. Turn the equipment On/Off switch to On.
5. Set scope time base select to 1.0 second per cm or 0.5 second per cm (user's preference).
6. Set storage scope to STORAGE mode.
7. Attempt access to hazard (operate interlock).
8. Monitor voltage on scope and time to decay to 42.4 V and record.
9. Calculate value for J (Energy)

   Energy can be calculated from the formula:

$$J = 5 * 10^{-7} CV^2$$

   where

   C = Capacitor rated value in microfarads
   V = Volts
   J = Joules

10. Repeat steps 3 through 9 for any other hazards requiring test.

For Mechanical Hazard

1. Connect the voltage source to either a 50 Hz or 60 Hz frequency source, whichever is appropriate; then set the voltage source to the proper voltage for the equipment under test per Table 1.
2. Turn the equipment On/Off switch to On.
3. Attempt access to hazard using test finger as quickly as possible.

Reactivation

With equipment power on and interlock open, attempt to reactivate interlock using test finger.

PASS/FAIL CRITERIA

The measured voltage and calculated energy of the capacitor shall not exceed 42.4 V peak or 60 Vdc and 20 joules:

a. Two seconds after being de-energized in operator access areas unless contact is likely in less time; and
b. Five minutes after being deenergized, for service areas that are provided with a tool-operated cover or guard and a warning label on the equipment

NOTE

The 5-minute limit is a Digital internal requirement.

c. Mechanical movement shall be an acceptably safe level before access can be gained.

6 119-TM-E4: TEST METHOD FOR TEMPERATURE RISE

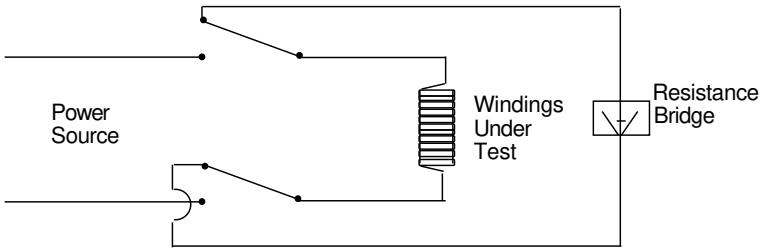
PURPOSE

This test method is to ensure that the temperature rise of critical components in a fully loaded product is within safe limits for the operating voltage and environmental temperatures specified in the applicable product specification.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clauses 4.4.2 Minimizing the risk of ignition, 5.1 Heating, and Appendix E Temperature Rise of a Winding.

Figure 5: Rise of Resistance Measurement Circuit



At the beginning of the test, the windings shall be at room temperature.

It is recommended that the resistance of windings at the end of the test be determined by taking resistance measurements as soon as possible after switching off, and then at short intervals so that a curve of resistance against time can be plotted for ascertaining the resistance at the instant of switching off.

Components typically requiring testing are:

a. All magnetics
b. Line filters
c. Filter capacitors
d. Bridge rectifiers (insulation, heat sink)
e. Fan cores
f. Thermal switch locations
g. Circuit breaker bodies
h. Print heads
i. Drive and take-up motors
j. Blower assemblies
k. Operator touchable surfaces
l. Digital Service touchable surfaces
m. Insulation retaining hazardous live parts

For equipment with multiple-rated frequencies, tests at each frequency may be avoided if the worst-case frequency can be determined, and testing is performed at that frequency. Justification of this would include a comparative test at each frequency on a similar circuit (that is, switching supply, linear supply, resonant transformer, motor, and so forth) and a written explanation of the technical reasons why that frequency results in the highest temperature rise. This justification shall accompany the test data.

TEST EQUIPMENT

- Autotransformer
- Magtrol 4612 (single-phase) or 4614 (3-phase) power analyzer or equivalent
- Fixed or programmable loads, if required
- Thermocouple and data logger or thermal meter calibrated for 30 AWG iron-constantan thermocouples or equivalent
- Thermal epoxy or duct tape
- Resistance bridge, if applicable
- DPDT switch

TEST PROCEDURE

Using Thermocouple Method

1. Using thermal epoxy or duct tape, locate the thermocouples on components as specified by the Product Safety Engineer.
2. Perform two tests, one at the upper and one at the lower voltage, as in Table 2. If more than one power supply range is specified for the equipment, the two tests are performed at each of the supply ranges.

Table 2: Supply Voltage Test Points (Volts rms)

Nominal	Lower	Upper
101	90	110
120	104	128
202	180	220
208	180	220
220	190	235
230	200	244
240	208	256
380	331	407
400	346	422
415	360	443

3. Connect the voltage source to a 50-Hz supply and set to first test voltage. Record ambient temperature and operate equipment under test until thermal equilibrium is reached. Record temperatures.
4. Repeat step 3 with the voltage source connected to a 60-Hz supply.
5. Use recorded data to determine worst-case frequency based on highest temperature.

6. Connect the voltage source to the worst-case frequency source as determined in step 5 and set to the next test voltage. Operate until thermal equilibrium is reached. Record temperatures.
7. Repeat step 6 for each required test voltage.
8. Calculate and record temperature rises.

Using Rise of Resistance Method

1. Set up the test circuit per Figure 5.
2. Make initial resistance readings, and record the room ambient.
3. Determine the test voltages per Table 2.
4. Connect the voltage source to a 50-Hz supply, set to the first test voltage, and operate the equipment under test for seven hours.
5. Turn off the voltage source and immediately move the switch to the resistance bridge and record the resistance readings and times at short intervals. Note and record the room ambient. See the appropriate clauses noted in the Requirements for method of determining actual temperature.
6. Repeat steps 4 and 5 with the voltage source connected to a 60-Hz supply.
7. Use the data recorded in steps 5 and 6 to determine the worst-case frequency based on the highest temperature.
8. Connect the voltage source to the worst-case frequency source, set to the next test voltage, and operate the equipment under test for 7 hours.
9. Repeat step 5.
10. Repeat steps 8 and 9 for each required test voltage.

PASS/FAIL CRITERIA

Temperature rises shall not exceed the values specified in Table 3.

Table 3: Operating Temperature Rise Limits

	Temperature Rise (K)			
	DEC STD 102 Class			Other
	A	B	C	
Parts		(Note 5)		(Note 6)
Windings, if winding insulation is made of:				
Class 105 (Class A) material	68	60	50	100
Class 120 (Class E) material	83	75	65	115
Class 130 (Class B) material	88	80	70	120
Class 155 (Class F) material (Note 3)	108	100	90	140
Class 180 (Class H) material (Note 3)	133	125	115	165

Table 3 (Cont.): Operating Temperature Rise Limits

	Temperature Rise (K)			
	DEC STD 102 Class			Other
	A	B	C	
Parts		(Note 5)		(Note 6)
Outer surface for external enclosures which may be made of:				
Metal	38	30	20	70
Ceramic	48	40	30	80
Rubber, plastic or similar material	63	55	45	95
Handles, knobs, grips and the like which in normal use are continuously held, and and are made of:				
Metal	23	15	5	55
Ceramic	33	25	15	65
Rubber, plastic or similar material	43	35	25	75
Handles, knobs, grips and the like which are normally held or touched momentarily and are made of:				
Metal	23	15	5	55
Ceramic	38	30	20	70
Rubber, plastic or similar material	43	35	25	75
Thermoplastic material used as insulation			See Note 4	
Other parts			See Note 2	
Electrolytic capacitors	33	25	15	65
Other capacitors	58	50	40	90
Fuses	58	50	40	90
Field-wiring terminals	43	35	25	75
Wood, fiber, or other combustible material	58	50	40	90
Phenolic insulation	118	110	100	150
Box or wiring area for power cords	58	50	40	90
Insulated conductor of rated temperature t (Note 8)	t-32	t-40	t-50	t

NOTES

1. **When the temperature rise of windings is determined using the thermocouple method, these figures are reduced by 10 K, except in the case of motors.**
2. **The temperature rise for a given insulation material is limited to that specified in IEC Publication 85 or this table, whichever is less.**
3. **Motors with windings of Class F or H insulation materials are required to be so marked.**
4. **Due to their wide variety, it is not possible to specify permissible temperature rises for thermoplastic materials. These shall withstand the mechanical strength tests specified in 119-TM-N7 through 119-TM-N12.**

5. ***DEC STD 102-0 Environmental Standard for Computers and Peripherals - General Test Requirements*** **identifies operating temperature ranges for the following classes.**

DEC STD 102-0 Class	Maximum Ambient Operating Limit
A	32°C
B	40°C
C	50°C

Insulation Classes A, E, B, F, and H identify insulation system construction as defined by UL, IEC, and CSA standards.

UL and CSA have no classification corresponding to Class E but will evaluate such, if requested.

6. **For products specifying a temperature range other than DEC STD 102-0 Class A, B, or C, calculate the allowed rise during test by subtracting the specified maximum ambient for the equipment from the maximum allowable temperature.**

   The maximum allowable temperature has been calculated from the reference standards by adding the permitted rise to the assumed ambient temperature (usually 25°C).

7. **These tables are corrected for Digital advertised ambient temperatures as required by IEC 950 paragraph 1.4.7. For the purposes of test, the ambient temperatures can be assumed to be constant. That is, a part operating at a temperature of 50°C in an ambient temperature of 20°C can be expected to operate at 60°C in a 30°C ambient. This assumption of linearity has been found to be acceptable for the purposes of safety testing.**

8. **t = 50 K unless specifically rated otherwise.**

9. **For insulation classes other than Class A, either recognized systems must be used or test data must be provided as requested by the agency.**

7 119-TM-E5: TEST METHOD FOR INPUT CURRENT

PURPOSE

This test method is to determine that the input line current drawn from a fully loaded product does not exceed the nameplate rating by more than 10% at rated voltage.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 1.6.1 Power Interface.

TEST EQUIPMENT

- Autotransformer
- Magtrol 4612 (single-phase) or 4614 (3-phase) Power Analyzer or equivalent
- Fixed or programmable loads, if required
- Ammeter

TEST PROCEDURE

1. Determine the rated (nominal) voltage.
2. Connect the voltage source and turn the equipment on.
3. Record the stabilized input current.

PASS/FAIL CRITERIA

The input current shall not exceed the nameplate rating value by more than 10 percent.

8 119-TM-E6: TEST METHOD FOR LEAKAGE CURRENT

PURPOSE

This test method is to determine that the leakage current flow of a fully loaded product is within specified limits (according to the product's specification) at the nominal and upper limits of the operating voltage.

REQUIREMENT

In accordance with *DEC STD 122-0 AC Power Line Standard: Design Requirements and Guidelines*, in order that the 3.5 milliampere requirement be achievable, the maximum limit for any single option with a power supply and designed for cabinet mounting shall not exceed 0.5 mA rms and for any power controller shall not exceed 1.5 mA rms.

This method tests for compliance to IEC 950 requirements, clause 5.2 Earth Leakage Current, Appendix D Measuring Instrument for Earth Leakage Current Test, and Appendix G, Earth Leakage Current for Equipment Intended to be Connected Directly to IT Power Systems.

TEST EQUIPMENT

- Autotransformer capable of supplying the equipment in accordance with Table 4
- Measuring instrument in accordance with Appendix D (See IEC 950.)
- Isolating transformer (optional)

Table 4: Supply Voltage Test Points (Volts rms)

Nominal	Lower	Upper Limit
101	90	110
120	104	128
202	180	220
208	180	220
220	190	235
230	200	244
240	208	256
380	331	407
400	346	422
415	360	443

TEST PROCEDURE

For example, with equipment rated 100-120/220-240, 50-60 Hz, the test points would be 128 and 256 volts at 60 Hz. **Single-Phase Measurements**

1. Perform two tests, one at the upper and one at the lower voltage, as in 4. If more than one power supply range is specified for the equipment, the two tests are performed at each of the supply ranges.
2. Set up the test circuit as in Figure 6.
3. Turn on and connect to a source with a frequency equal to the highest frequency marked on the equipment nameplate, and set the first test voltage.

4. Record values for leakage current.
5. Turn the equipment On/Off switch to the Off position.
6. Record values for leakage current.
7. Repeat steps 3 through 6 with the meter connected to the other mains lead.
8. Repeat steps 3 through 7 for each required test voltage.

Figure 6: Test Circuit for Earth Leakage Current on Single-Phase Equipment

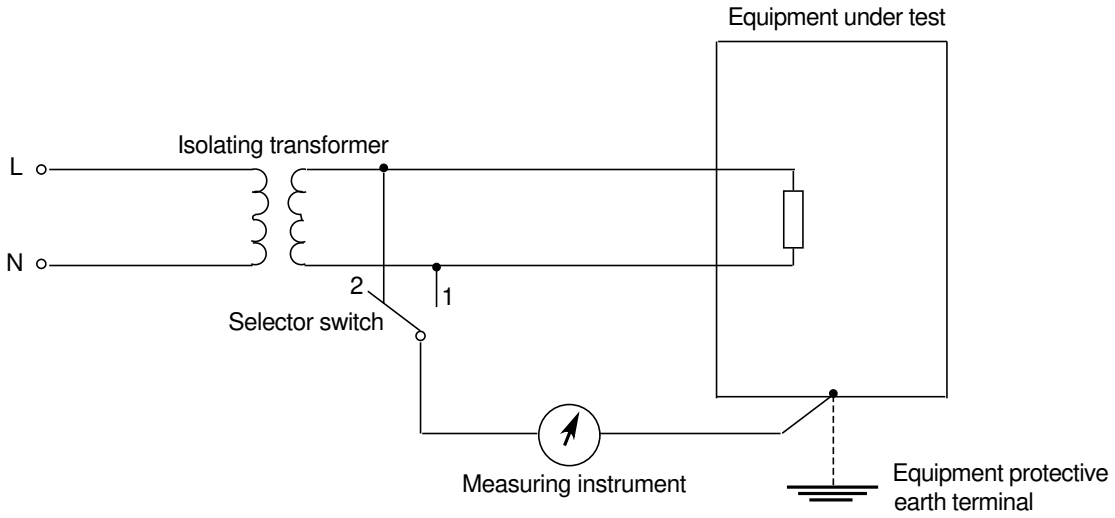


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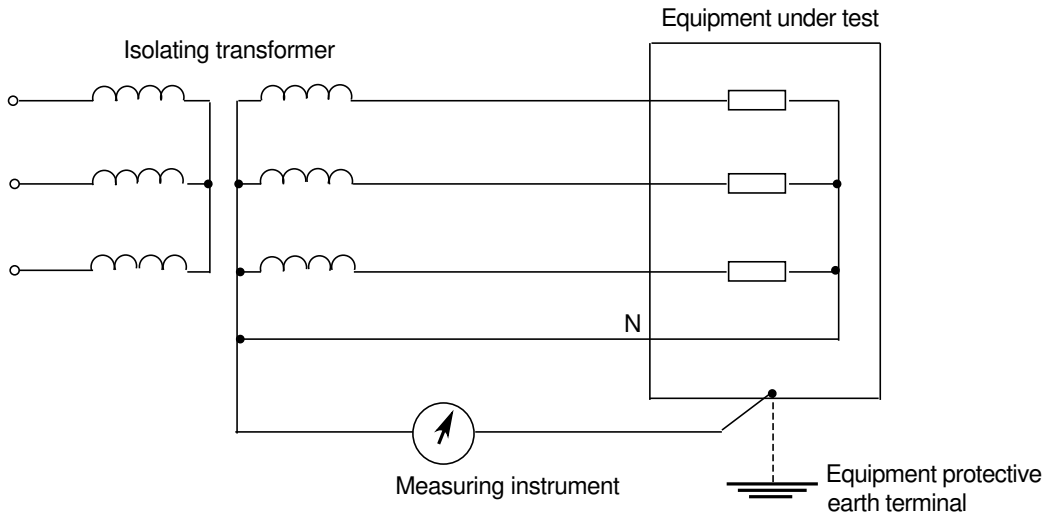
Figure 7: Test Circuit for Earth Leakage Current on Three-Phase Equipment



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Three-Phase Measurements

1. Determine the test voltages as in Table 4.
2. Set up the test circuit as in Figure 7.
3. Turn on and connect to a source with a frequency equal to the highest frequency marked on the equipment nameplate, and set the first test voltage.
4. Record values for leakage current.
5. Turn the equipment On/Off switch to the Off position.
6. Record values for leakage current.
7. For the phase under test, disconnect any component between phase and earth ground.
8. Repeat steps 3 through 6.
9. Repeat steps 3 through 8 for each remaining phase.
10. Repeat steps 3 through 9 for each required test voltage.

PASS/FAIL CRITERIA

The leakage current shall not exceed the values listed in Table 5.

Table 5: Maximum Earth Leakage Current (IEC Table XIV)

Class	Type of Equipment	Maximum Leakage Current (mA)
II	All	0.25
I	Handheld	0.75
I	Movable (other than handheld)	3.5
I	Stationary, pluggable type A	3.5
I	Stationary, permanently connected or pluggable type B:	
	—Not subject to the conditions in subclause 5.2.5	3.5
	—Subject to the conditions in subclause 5.2.5	5% of input current

9 119-TM-E7: TEST METHOD FOR DIELECTRIC STRENGTH

PURPOSE

This test method is to determine that a unit is capable of withstanding for one minute, without breakdown, the application of an essentially sinusoidal voltage at a frequency in the range of 40 to 70 Hz.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clauses 2.1.8, 2.1.9, 2.2.3, 2.9.4, 5.3 Electric Strength, and Appendix C3 Electric Strength Requirements.

TEST EQUIPMENT

- HI-POT tester
- Metal foil and sand bag, if applicable
- Humidity chamber, if required

TEST PROCEDURE

These sections describe the procedures for humidity conditioning and the dielectric test.

Humidity Conditioning

If humidity conditioning is not required, proceed to the Dielectric Test section.

1. Place the equipment under test in the humidity chamber. Preheat the equipment for four hours at a temperature approximately 4°C above the dry bulb temperature at which the humidity conditioning will be performed. This will minimize the formation of condensation due to going through dew point during the test.
2. At the completion of the preheating, set the dry bulb and wet bulb controls to achieve a relative humidity in the chamber of 93 ± 2% at a temperature maintained within 1°C of any convenient value between 20°C and 30°C. Soak the the equipment in this environment for 48 hours.

   During this treatment the component or subassembly shall not be energized.
3. At the completion of the humidity conditioning and with the equipment still in the humidity chamber, proceed to the Dielectric Test section.

Dielectric Test

1. Connect the HI-POT tester to the insulation under test. Application points shall be specified by the Product Safety Engineer based upon the grade and application of insulation. Attention should be paid to applications of the test to floating circuits, for example, secondaries. Connection or reference of these circuits may be necessary.
2. Set the equipment On/Off switch to the On position. (No power is applied to the equipment.)
3. Turn the HI-POT tester On and gradually increase the test voltage as specified in Table 6 for the appropriate grade of insulation and the working voltage. Hold this value for one minute.
4. Record the results and reduce the voltage to 0 before turning the HI-POT tester off.

5. Repeat steps 1 through 4 for each type of insulation specified for test.

Table 6: Transformer Electric Strength

Grade of Insulation	Insulation Insulation between (See notes 1, 2, 3)	And	Test Voltage	Key to Figure 8
1.Operational	SELV winding	- Earthed body, core, or screen	See Note 1	1a
		- Double-insulated body, core, or screen		1b
		- Earthed SELV winding	See Note 4	1c
	ELV winding - Earthed body, core, or screen			1d
				1e
				1f
	- Basic-insulated body, core, or screen			1g
	- Earthed SELV winding			
	- Another ELV winding			
	Earthed hazardous voltage secondary winding	- Another earthed hazardous voltage secondary winding		1h
	Between series or parallel sections of a winding.			
2. Basic	Mains winding	- Hazardous voltage secondary winding		2a
			Table 7	2b
		- ELV winding	Primary basic	2c
		- Earthed SELV winding		2d
		- Basic-insulated body, core, or screen		2e
	Earthed or unearthed hazardous voltage winding	- Unearthed hazardous voltage secondary winding	Table 7	2f
			Secondary	2g
		- ELV winding	basic	2h
		- Earthed SELV winding		2j
		- Basic-insulated body, core, or screen		2k
		- Earthed body, core, or screen		
3.Supplementary	ELV winding	- Double-insulated body, core, or screen	Table 7 Supplementary	
		- Unearthed SELV winding	See Note 6	3b
	Basic-insulated body or screen	- Double-insulated body, core, or screen		3c
		- Unearthed SELV winding		3d
4.Supplementary or reinforced	Unearthed hazardous voltage secondary winding	- Unearthed SELV winding	See Note 5	4a
		- Double-insulated body, core, or screen		4b
5. Reinforced	Main winding	- Unearthed SELV winding	Table 7	5a
		- Double-insulated body, core, or screen	Primary reinforced	5b

Table 6 (Cont.): Transformer Electric Strength

Grade of Insulation	Insulation Insulation between (See notes 1, 2, 3)	And	Test Voltage	Key to Figure 8
	Earthed hazardous voltage secondary winding	- Unearthed SELV winding - Double-insulated body, core, or screen	Table 7 Secondary reinforced	5c 5d

Note

Notes to Table 6

1. The expression *SELV winding* is used as a specification (for convenience) in Table 6 and should be read as *winding connected in, or to a SELV circuit*. Similarly, *ELV winding* should be read as *winding working at ELV*.
2. Bodies, cores, and screens may have one or two levels of protection from parts at hazardous voltage. If they are protected by double or reinforced insulation, they are termed *double insulated* in the table. If they are protected by basic insulation plus protective earthing, they are termed *earthed* in the table. If they have no second level of protection, they are termed *basic-insulated* and must not be accessible.
3. In the table, a part of a winding is termed *unearthed* if it is not connected to a protective earthing terminal or contact in such a way as to not exceed 0.1 ohms to earth (though it will not necessarily be at earth potential). Therefore, an ELV winding is unearthed; and an earthed ELV winding would be a SELV winding.
4. See the Product Safety Engineer for operational insulation requirements.
5. Insulation between an unearthed hazardous voltage secondary and an unearthed accessible part or SELV winding must satisfy the more demanding of the following requirements.

   – Reinforced insulation based on the working voltage equal to the voltage of the hazardous voltage secondary; or
   – Supplementary insulation based on the working voltage equal to the voltage between the hazardous voltage secondary and another hazardous voltage secondary or a mains winding.
   Which of these requirements is more demanding will depend on the relative voltages of the windings.
6. Where unearthed parts of ELV windings are separated from hazardous voltages by basic insulation only, the working voltage of the supplementary insulation between such parts and unearthed accessible parts or SELV windings is the same as the most demanding working voltage for the basic insulation. The most demanding working voltage may be a mains primary winding or to a secondary circuit and a test voltage is selected accordingly.
7. Telecommunications products in the U.K. must comply with BS 6301, *Safety Requirements for Apparatus for Connection to British Telecommunications Networks*. The test for reinforced insulation is performed at 3750 Vac after humidity preconditioning.

Table 7: Test Voltage for Electric Strength Tests (Part I)

	Test Voltage (in volts, rms) Points of Application (as appropriate)						
	Primary to body Primary to secondary Between parts in primary circuits					Secondary to body Between independent secondaries (see Condition 3)	
Working Voltage Grade of Insulation	U ≤ 130 V rms	130 V < U ≤ 250 V rms	250 < U ≤ 1000 V rms	1 kV < U ≤ 7 kV rms	7 kV < u ≤ 35 kV rms	u ≤ 42.4 V peak, or 60 V dc	42.4 V or 60 V dc < U ≤ 7 kV rms
Operational (see Condition 1)	1000	1500	See Va in Table 8	See Va in Table 8	1.5 U	500	See Va in Table 8
Basic, supplementary	1000	1500	See Va in Table 8	See Va in Table 8	1.5 U	No test	See Va in Table 8
Reinforced	2000	3000	3000	See Vb in Table 8	1.5 U	No test	See Vb in Table 8

Conditions Applicable to Table 7

1. In general, no test is applied to operational insulation, unless option (b) of subclause 5.4.4 has been selected.
2. The test voltages are for application to solid insulation at any altitude. For clearances the voltages may be reduced for altitude by the following multipliers:

   Altitude, Coefficient
   Sea level (0), coefficient 1
   500, 0.94
   1000, 0.89
   2000, 0.79
3. For working voltages exceeding 7 kV in secondary circuits, the same values as for primary circuits shall apply.

Table 8: Test Voltages for Electric Strength Tests (in rms)

U	Va	Vb	U	Va	Vb	U	Va	Vb
24	500	800	218	1391	2226	1652	3959	3959
25	510	815	227	1418	2268	1701	4037	4037
26	519	830	237	1446	2314	1751	4117	4117
27	528	845	247	1474	2359	1803	4199	4199
28	537	859	257	1502	2403	1856	4283	4238
29	546	845	268	1531	2450	1912	4369	4369
32	571	914	305	1626	2601	2087	4636	4636
33	580	927	319	1660	2656	2149	4728	4728
35	596	953	333	1693	2709	2213	4823	4823
37	611	978	347	1726	2762	2279	4920	4920
39	626	1002	362	1760	2816	2347	5018	5018
41	641	1026	378	1796	2873	2416	5118	5118
43	655	1048	395	1833	2933	2488	5220	5220
45	669	1071	415	1875	3000	2562	5325	5325
47	683	1093	433	1913	3000	2639	5432	5432
49	696	1114	452	1951	3000	2718	5541	5541
51	709	1135	472	1991	3000	2799	5652	5652
53	722	1155	493	2031	3000	2882	5765	5765
55	735	1175	515	2073	3000	2967	5880	5880
58	753	1205	537	2114	3000	3056	5998	5998
61	771	1233	561	2157	3000	3147	6118	6118
64	788	1261	585	2199	3000	3240	6240	6240
67	805	1288	610	2242	3000	3337	6365	6365
70	821	1314	637	2288	3000	3436	6492	6492
73	838	1340	665	2334	3000	3538	6622	6622
76	853	1365	694	2381	3000	3643	6754	6754
79	869	1390	725	2429	3000	3751	6889	6889
82	884	1414	757	2478	3000	3863	7027	7027
86	904	1446	790	2528	3000	3978	7168	7168
90	923	1477	825	2579	3000	4056	7311	7311
94	942	1507	861	2631	3000	4218	7457	7457
98	960	1536	899	2684	3000	4343	7606	7606
102	978	1565	938	2738	3000	4472	7758	7758
107	1000	1600	979	2792	3000	4605	7913	7913
112	1000	1634	1000	2820	3000	4742	8071	8071
117	1000	1668	1030	2877	3000	4883	8232	8232
122	1000	1701	1061	2935	3000	5028	8397	8397
127	1000	1733	1096	3000	3000	5178	8565	8565
130	1000	1751	1129	3061	3061	5332	8736	8736
131	1099	1758	1163	3123	3123	5491	8911	8911
137	1122	1795	1197	3184	3184	5654	9089	9089
143	1144	1831	1233	3249	3249	5822	9271	9271
149	1166	1866	1270	3314	3314	5995	9456	9456
155	1188	1900	1308	3381	3381	6173	9645	9645
162	1212	1940	1347	3449	3449	6357	9838	9838
169	1236	1978	1387	3518	3518	6546	10035	10035
176	1260	2016	1428	3587	3587	6741	10236	10236
184	1286	2058	1470	3658	3659	6942	10441	10441
192	1312	2099	1513	3730	3730	7000	10500	10500
200	1337	2139	1558	3805	3805			
209	1364	2183	1604	3880	3880			

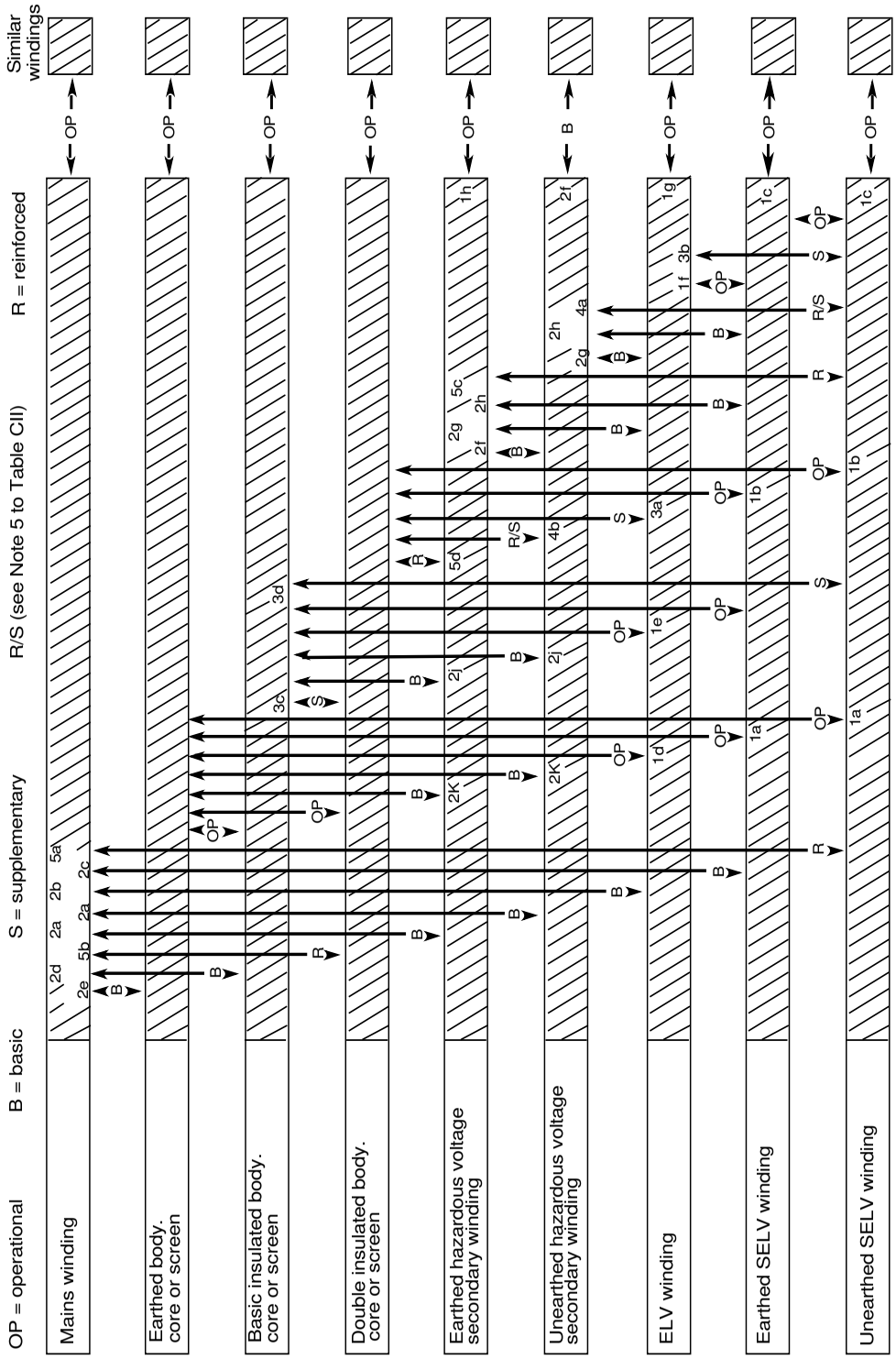
(Continued next column)

(Continued next column)

(1) At these voltages the values of Vb are determined by the general curve $Vb = 183.2U^{0.4638}$ and are not 1.6Va.

(2) Interpolation is allowed between adjacent points in this table.

Figure 8: Grades of Insulation in Transformers



PASS/FAIL CRITERIA

There shall be no indication of breakdown during the test.

10 119-TM-E8: TEST METHOD FOR INTERLOCK ENDURANCE

PURPOSE

This test method is to verify that a safety interlock system failure will not create a hazard.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 2.8.4 Interlock endurance.

TEST EQUIPMENT

- Programmable loads as required
- Equipment for cycling through 10,000 cycles

TEST PROCEDURE

For interlocks protecting moving parts, cycle interlocks through 10,000 cycles, switching the load imposed in the application.

PASS/FAIL CRITERIA

The interlock system shall not fail other than in a safe mode.

11 119-TM-E11: TEST METHOD FOR OZONE

PURPOSE

This test method is to ensure that the emitted levels of ozone do not exceed the maximum allowable limit.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 1.7.2 Marking and Instructions (Ozone).

TEST EQUIPMENT

The test chamber shall be a room of approximately 28 cubic meters (1000 cubic feet). The room shall be of a nonreactive wall material (a half-life of ozone greater than 5 minutes is considered acceptable). Circulation necessary to maintain temperature and humidity shall be kept to a minimum, makeup air being no more than 0.5 changes/hour. The decay constant of the room shall be determined as described in the procedure below. The procedure will require:

- Ozone measuring instrument; Thermo Electron Model 49-100 or equivalent
- An ozone generator for room calibration purposes (a printer with the ozone filter removed can be used)

TEST PROCEDURE

Ozone concentration measurements are to be made at all probable operator positions with the unit installed in the center of a closed room of approximately 28 cubic meters (1000 cu ft). The appliance is to be operated in the same manner as for the tests in 119-TM-E4, Test Method for Temperature Rise. The test room is to be at a temperature of 23°C ± 2 K and 40 to 50% relative humidity. There shall not be any air circulation other than that resulting from the normal machine operation and makeup air.

If productive or normal operation of the machine is possible with any of its fans or heaters not functioning, or with paper or fluid supplies or both exhausted, the test is to be repeated a sufficient number of times with the various components not operating or without paper or fluid to determine that these conditions do not result in ozone concentrations above those specified. Selection of those conditions likely to increase ozone emission and require further testing shall be done by the Product Safety Engineer.

Room calibration

NOTE

This needs to be performed only once to determine room characteristics.

a. Establish the room ambient temperature to 23°C ± 2 K, 40 to 50% relative humidity, and allow it to stabilize.

b. Run an ozone generator in the room to elevate the ozone to about 10 times normal ambient levels. Makeup air should be 0.5 changes/hour, with no supplemental circulation provided.

c. Turn off the ozone generator.

d. Measure the time needed for the ozone level to fall by 50%.

   This time is the decay rate (half-life) of the room under the specified conditions.

e. Allow time for the room to return to normal ambient levels before continuing with the product test.

Product test:

a. Locate the product in the center of the test chamber. If product is a floor model or has a stand provided, it should be set up as recommended. If it is a desktop model, it should be placed on a table approximately 0.75 m above the floor.

b. Set up probe at operator position test point(s), normally 0.3 m in front of the unit and 1.2 m above the floor. Additional points may be specified or requested by the Product Safety Engineer or design engineering. These might be measurements taken in order to plot isoexposure curves around the product.

c. Establish room ambient to 23 ± 2°C, 40 to 50% relative humidity. Allow it to stabilize, and measure background ozone level.

d. The machine is to be run at maximum rate consistent with reasonable replenishment of supplies.

e. Measurements are to be made continuously or at a sample rate that approximates continuous data for the purposes of integration using the formula shown in step 7.

f. The test is continued for a duration of 8 hours.

g. The time-weighted average (TWA) is calculated from the formula:

   a. TWA = integral from t=0 to T of M with respect to time, divided by total time of interest.

      where:

      TWA is the time-weighted average in parts per million (ppm).
      M is the measured value in ppm.
      T is the total test period in minutes.
      For permissible 8-hour exposure limit (PEL), T is 480 minutes (8 hours).
      For short-term exposure level (STEL) T is 10 minutes.

h. Repeat steps 5 through 7 with the machine running at three times the duty cycle used for Digital Service contracts (assuming 8 hour day, 20 day month). For example, for a Digital Service rate of 20,000/month, the machine would be run at the rate of 20,000/9600 minutes or an average rate of 2.08 copies per minute.

PASS/FAIL CRITERIA

When run at a continuous rate, a unit shall not exceed a permissible exposure limit (PEL) above background in excess of 0.1 ppm over an 8-hour period nor a STEL of more then 0.3 ppm over a 10-minute period. The concentration at STEL limits shall not occur more frequently than four times in eight hours.

When run at a rate of three times the Digital Service contract rate, a unit shall not exceed a PEL above background in excess of 0.05 ppm over an 8-hour period nor a STEL of more then 0.15 ppm over a 10-minute period. The concentration at STEL limits shall not occur more frequently than four times in 8 hours.

12 119-TM-N1: TEST METHOD FOR ACCESSIBILITY

PURPOSE

This test method is to ensure enclosures are designed to prevent contact with mechanical or electrical shock or energy hazards.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clauses 2.1.2, 2.1.3, and 2.1.5 Protection Against Electric Shock and Energy Hazards, clause 3.2.3 Connections to primary power, and clause 4.1.2 Mechanical Hazards.

TEST EQUIPMENT

- IEC test finger
- IEC test pin
- IEC unjointed test finger

TEST PROCEDURE

1. Remove or open all operator access covers.
2. Apply the test pin without appreciable force to all operator access areas.
3. Apply the test finger without appreciable force to all operator access areas.
4. Apply the unjointed test finger with a force of 30 N to all apertures to determine if access can be obtained.
5. Push the test finger into the areas accessed in step 4 with the test finger in all positions.
6. Verify if the insulation of internal wiring at ELV is accessible to an operator.
7. Verify, using the test finger, if appliance inlets have parts at hazardous voltages accessible during insertion or removal of the connector.

PASS/FAIL CRITERIA

The test finger shall *not:*

1. Contact bare parts at ELV nor hazardous voltages
2. Contact operational or basic insulation of parts or wiring at ELV or hazardous voltages
3. Contact unearthed conductive parts separated from parts at ELV or hazardous voltages by operational or basic insulation only
4. Bridge two bare parts, one of which may be an earthed conductive part, between which a hazardous energy level exists
5. Contact parts at hazardous voltage accessible during insertion or removal of a connector
6. Contact hazardous moving parts

The test pin shall *not:*

Contact bare parts at hazardous voltage when applied to apertures in an electrical enclosure. *Exception:* fuseholder, connectors, socket or outlets.

13 119-TM-N2 TEST METHOD FOR PHYSICAL STABILITY: 10 DEGREE TILT

PURPOSE

This test method is to ensure that a unit will not tip over when tilted 10 degrees from the normal freestanding upright position.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 4.1.1 Stability Hazards.

TEST EQUIPMENT

Universal protractor or tilt table or 10-degree ramp or other suitable measuring equipment.

TEST PROCEDURE

NOTE

Use at least two people to conduct this test on floor-standing equipment.

1. Place the universal protractor on top of the unit to be tested where meter deflection will occur when unit is tilted.
2. With doors, drawers, and so forth closed, and casters locked or blocked in their most disadvantageous position (movable casters should be perpendicular to the force being applied), tilt the unit 10 degrees from its normal upright position in the following directions: side to side, front to back, and back to front.
3. Record results.

NOTE

Presently Digital does not use a tilt table or ramp. When a test lab installs such a device, procedures will be developed to support this test.

PASS/FAIL CRITERIA

The unit shall not tip over.

14 119-TM-N3: TEST METHOD FOR PHYSICAL STABILITY: 800-NEWTON FORCE (STEP)

PURPOSE

This test method is to determine that a floor-standing unit is not physically unstable when a constant downward force of 800 N is applied at a point of maximum moment to any horizontal working surface or surface offering an obvious foothold at a height not exceeding one meter from the floor.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 4.1.1 Stability Hazards.

TEST EQUIPMENT

- Three 50-pound bars of steel
- Three 10-pound bars of steel
- Electric hoist
- Alternately, a force gauge capable of applying 800 N

TEST PROCEDURE

1. Lock or block the unit's casters in their most disadvantageous position. If jacks are provided, then the test is performed with the jacks lowered and the unit reasonably level.
2. Close all doors, drawers, and so forth.
3. Suspend weights on hoist over surface to be tested.
4. Gradually lower weights or apply the force gauge onto surface until total weight is supported by the unit under test.
5. Repeat step 4 on all working surfaces or foothold areas being tested.

PASS/FAIL CRITERIA

The unit shall not tip over.

15 119-TM-N4: TEST METHOD FOR PHYSICAL STABILITY: 250-NEWTON FORCE (OPERATOR)

PURPOSE

This test method is to determine that a floor-standing unit will not become physically unstable during normal use.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 4.1.1 Stability Hazards.

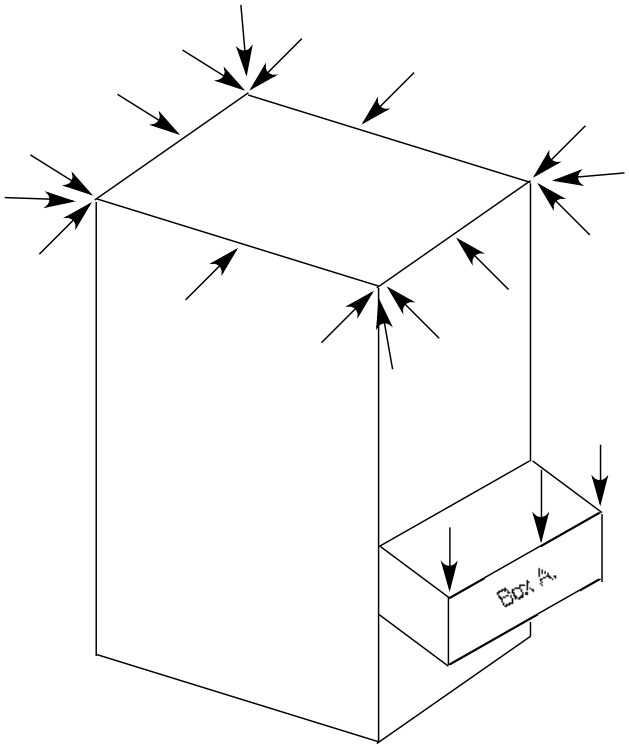
TEST EQUIPMENT

- Force gauge capable of applying 250 N

TEST PROCEDURE

1. Weigh unit to be tested.
2. Determine test force. The test force is 20% of the unit weight or 250 N, whichever is less.
3. Lock or block the unit's casters in their most disadvantageous position. If jacks are provided for final installation, then the test is performed with the jacks lowered and the unit reasonably level.
4. Place all doors, covers, gates, drawers, and so forth in their most disadvantageous position so they may be opened by the operator. A stabilizing means cannot be used unless its operation is automatic in nature or interlocked.
5. Apply a force equal to the amount determined in step 2. Figure 9 provides guidelines for application of this force.

Figure 9: Example of Worst-Case Test Points



Arrows: Indicate direction of applied force

Box A : Is accessible during service and must be tested in extended mode.

PASS/FAIL CRITERIA

The unit shall not tip over when the force is applied at any test point.

16 119-TM-N5: TEST METHOD FOR PHYSICAL STABILITY: 250-NEWTON FORCE (SERVICING)

PURPOSE

This test method is to determine that a floor-standing unit will remain physically stable during servicing.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 4.1.1 Stability Hazards.

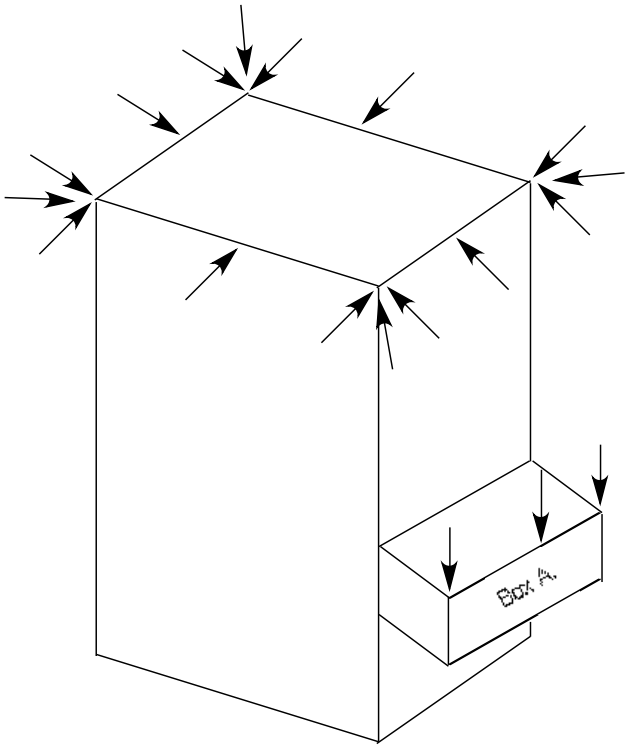
TEST EQUIPMENT

- Force gauge capable of applying 250 N

TEST PROCEDURE

1. Weigh unit to be tested.
2. Determine test force. The test force is 20% of the unit weight or 56 pounds, whichever is less.
3. Extend stabilizer means, if applicable.
4. Place all doors, covers, gates, drawers, and the like, in their most disadvantageous position.
5. Apply a force equal to the amount determined in step 2. Figure 10 provides guidelines for application of this force.

Figure 10: Examples of Worst-Case Test Points



Arrows: Indicate direction of applied force

Box A : Is accessible during service and must be tested in extended mode.

PASS/FAIL CRITERIA

The unit shall not tip over when the force is applied at any test point.

17 119-TM-N6: TEST METHOD FOR CHASSIS SLIDE STRENGTH

PURPOSE

This test method is to ensure that chassis slides will safely and dependably carry the weight of the unit.

REQUIREMENT

This test has no corresponding tests in other standards.

Slide-mounted equipment shall safely and dependably carry an 800 N stress in the operator position and half that for service positions, in addition to the normal load carried by the slides. Slide stop durability is also investigated.

This test is similar to test 119-TM-N3, except that no height limitations exist, and service conditions are tested as well. It was created to address problems experienced by Digital Equipment Corporation with chassis slides.

TEST EQUIPMENT

- Weights totaling 400 N and 800 N (40.8 and 81.6 kg; 90 and 180 lbs), or
- A force gauge capable of applying 800 N

TEST PROCEDURE

NOTE

Try to anticipate the possible failure modes in the following tests. The test engineer must position himself to avoid any falling parts. Measures may need to be taken to increase the stability of the equipment during the test. Slide strength, not equipment stability, is being tested.

Protective footwear and eye protection is required when performing this test.

1. Extend the chassis slide-mounted unit to the service position.
2. Apply a 400 N force either by weights or force gauge to the most unfavorable location of the extended unit.
3. If applicable, extend the chassis slide mounted unit to the operator position.
4. Apply an 800 N force to the most unfavorable location of the operator-positioned unit.
5. Extend the unit at a moderately fast rate allowing the slide stops to halt the unit. Severity of this test is left to the judgment of the test engineer, since adequately defined test criteria are not yet developed. It should represent worst normal use, but not abuse.

PASS/FAIL CRITERIA

The slides shall pass the force tests without dropping the unit, or sustaining any permanent damage or deformation.

NOTE

Failure of the slide stops may or may not indicate unsafe conditions, depending on the severity of the test. Any failure is cause for further evaluation by the Product Safety Engineer, the chassis slide Component Engineer, and possibly the slide manufacturer. Investigation of the failure mode should occur.

18 119-TM-N7: TEST METHOD FOR MECHANICAL STRENGTH OF ENCLOSURES AND GUARDS (BALL IMPACT TEST)

PURPOSE

This test method is to determine that the mechanical strength of the enclosure and guards can withstand an impact force of a 50 millimeter diameter, 500 gram steel ball dropped from a height of 1.3 meters without producing cracks or openings that could create a hazard during normal handling of the equipment.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clauses 4.2.1, 4.2.4, and 4.2.7 Mechanical Strength.

TEST EQUIPMENT

- Tape measure, 1.3 meters
- 50 millimeter diameter steel ball weighing 500 ± 25 grams
- Cord, 1.3 meters
- IEC test finger

TEST PROCEDURE

1. To test horizontal surfaces, support the enclosure or part of the enclosure in its normal position for the application of the impact.
2. Drop the steel ball from a height of 1.3 meters onto the horizontally supported surface of the enclosure.
3. To test vertical surfaces, support the enclosure or part of the enclosure in its normal position for the application of the impact.
4. Suspend the steel ball by a cord 1.3 meters above the surface to be tested and swing as a pendulum to apply a horizontal impact.
5. Inspect for cracks or openings that do not comply with the accessibility requirements of test Test Method For Accessibility, 119-TM-N1, and for other damage that results in the reduction of electrical spacings.

   In case of doubt, supplementary or reinforced insulation shall be subjected to an electric strength test. (119-TM-E7)

PASS/FAIL CRITERIA

a. There shall be no resultant cracks or openings that do not comply with Test 119-TM-N1.

b. There shall be no distortion that results in the reduction of spacings below the minimum values stated in Test 119-TM-N12.

c. There shall be no signs of interference with the operation of safety features such as thermal cutouts, overcurrent protection devices, or interlocks.

   Damage to finish, dents, and chips that do not adversely affect safety or protection against water, cracks not visible to the naked eye, and surface cracks in fiber-reinforced moldings and the like, is acceptable.

d. There shall be no damage to protective earthing paths that results in failure of Test 119-TM-N14.

e. There shall be no damage to supplementary or reinforced insulation that results in failure of Test 119-TM-E7.

f. There shall be no damage to strain reliefs that results in failure of Test 119-TM-N18.

19 119-TM-N8: TEST METHOD FOR HANDHELD EQUIPMENT DROP TEST

PURPOSE

This test method is to determine that the mechanical strength of handheld equipment can withstand the impact force when dropped 1 meter onto a hardwood floor without producing cracks or openings that could create a hazard during normal handling of the equipment.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clauses 4.2.1, 4.2.5, and 4.2.7 Mechanical Strength.

TEST EQUIPMENT

- Hardwood surface consisting of a layer of tongued and grooved oak flooring approximately 13 mm thick by 57 mm wide, mounted on two layers of plywood each 19 mm to 20 mm thick, all supported on a concrete or equivalent non-resilient floor.
- 1 meter measuring device

TEST PROCEDURE

1. Position the equipment under test 1 meter above the hardwood surface test floor in the position most likely to cause the most adverse results.
2. Drop it on the hardwood surface.
3. Repeat steps 1 and 2 two more times for a total of three.
4. Inspect for cracks or openings that do not comply with the accessibility requirements of Test 119-TM-N1, Test Method for Accessibility, and for other damage that results in the reduction of electrical spacings.

   In case of doubt, supplementary or reinforced insulation shall be subjected to an electric strength test (119-TM-E7).

PASS/FAIL CRITERIA

a. There shall be no resultant cracks or openings that do not comply with Test 119-TM-N1.

b. There shall be no distortion that results in the reduction of spacings below the minimum values stated in Test 119-TM-N12.

c. There shall be no signs of interference with the operation of safety features such as thermal cutouts, overcurrent protection devices, or interlocks.

   Damage to finish, dents, and chips that do not adversely affect safety or protection against water, cracks not visible to the naked eye, and surface cracks in fiber-reinforced moldings and the like, is acceptable.

d. There shall be no damage to protective earthing paths that results in failure of Test 119-TM-N14.

e. There shall be no damage to supplementary or reinforced insulation that results in failure of Test 119-TM-E7.

f. There shall be no damage to strain reliefs that results in failure of Test 119-TM-N18.

20 119-TM-N9: TEST METHOD FOR MECHANICAL STRENGTH OF ENCLOSURES: 30-NEWTON FORCE

PURPOSE

This test method is to determine that the mechanical strength of an internal enclosure is sufficient to withstand the forces expected in normal daily use without developing signs of interference with the operation of safety features that could result in a hazard.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 4.2.1, 4.2.2, and 4.2.7 Mechanical Strength.

TEST EQUIPMENT

- IEC unjointed test finger
- Chatillon force gauge or equivalent

TEST PROCEDURE

1. Disconnect the unit from the power source.
2. Apply a 30 ± 3 N force for five seconds through the IEC unjointed test finger to any internal enclosure.
3. Inspect and record the results of the test noting any openings and transient or permanent deflections of the enclosure that show signs of interference with the operation of safety features such as thermal cutouts, overcurrent protection devices, or interlocks.

   In cases of doubt, supplementary or reinforced insulation shall be subjected to an electric strength test. (119-TM-E7)

PASS/FAIL CRITERIA

a. There shall be no resultant cracks or openings that do not comply with Test 119-TM-N1.

b. There shall be no distortion that results in the reduction of spacings below the minimum values stated in Test 119-TM-N12.

c. There shall be no signs of interference with the operation of safety features such as thermal cutouts, overcurrent protection devices, or interlocks.

   Damage to finish, dents, and chips that do not adversely affect safety or protection against water, cracks not visible to the naked eye, and surface cracks in fiber-reinforced moldings and the like, is acceptable.

d. There shall be no damage to protective earthing paths that results in failure of Test 119-TM-N14.

e. There shall be no damage to supplementary or reinforced insulation that results in failure of Test 119-TM-E7.

f. There shall be no damage to strain reliefs that results in failure of Test 119-TM-N18.

21 119-TM-N10: TEST METHOD FOR MECHANICAL STRENGTH OF ENCLOSURES: 250-NEWTON FORCE

PURPOSE

This test method is to determine that the mechanical strength of the enclosure, external guards, and barriers will withstand a force of 250 N and not result in reduced spacings or distortion that could create a hazard during normal handling of the unit.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 4.2.1, 4.2.3 and 4.2.7 Mechanical Strength.

TEST EQUIPMENT

- A 30 millimeter diameter circular plane surface secured to a force gauge capable of measuring 250 N.

TEST PROCEDURE

1. Disconnect the unit from the power source.
2. Apply a 250 N force through the 30 millimeter diameter circular plane surface for 5 seconds to enclosure surfaces, guards, and barriers that are in the operator access area.
3. Inspect, measure, and record openings and deflections (transient and permanent) that could cause an opening or reduction of spacings that would not comply with the accessibility requirements of Test 119-TM-N1 (Test Method For Accessibility) and that could result in an unsafe condition or that show signs of interference with the operation of safety features such as thermal cutouts, overcurrent protection devices or interlocks.

   In case of doubt, supplementary or reinforced insulation shall be subjected to an electric strength test (119-TM-E7).

PASS/FAIL CRITERIA

a. There shall be no transient distortion that results in contact with bare live parts.

b. There shall be no permanent distortion that results in the reduction of spacings that would result in openings that do not comply with Test 119-TM-N1.

c. There shall be no resultant openings (transient or permanent) that would result in openings which do not comply with Test 119-TM-N1.

d. There shall be no signs of interference with the operation of safety features such as thermal cutouts, overcurrent protection devices, or interlocks. In case of doubt, supplementary or reinforced insulation shall pass the electric strength test.

22 119-TM-N11: TEST METHOD FOR MECHANICAL STRENGTH OF HANDLES AND KNOBS

PURPOSE

This test method is to determine that handles, knobs, grips, levers, and the like are reliably fixed so that they will not loosed in normal use and result in a hazard. This test also ensures that handles are sufficiently strong to support the weight of the unit.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 4.3.5 Construction Details.

TEST EQUIPMENT

Axial Force Test

- Chatillon force gauge or equivalent
- Vise or similar device to secure the equipment under test

Handle Strength Test

- Weights to equal four times the weight of the equipment under test
- Hoist
- Strap to connect handle to hoist
- Scale to weigh unit under test

TEST PROCEDURES

Axial Force Test

Secure the unit to the test bench and apply an axial force with the force gauge for one minute to the part under test.

a. If the shape of the parts under consideration is such that an axial pull is unlikely to be applied during normal use, the force shall be as follows.
    1. 15 N for operating means of electrical components
    2. 20 N in other cases

b. If the shape of the part being tested is such that an axial pull is likely to be applied, the force shall be as follows.
    a. 30 N for operating means of electrical components
    b. 50 N in other cases

Handle Strength Test

1. Weigh the equipment under test and attach four times this weight to the equipment or use the force gauge to apply a force equal to 4 times the measured weight.
    a. For units with more than one handle, test each handle with a proportionate amount of test weight or force based upon the percentage of weight sustained during normal use.

b. For units less than 25 kilograms and provided with more than one handle, but capable of being carried by a single handle, apply the full test weight or force to each handle.

2. Connect the hoist to the handle under test with a strap. The strap should be connected to apply the pull evenly over a 75 millimeter length at the center of the handle.
3. Raise the unit under test off the ground so that the handle supports the entire test weight. Apply the weight or force gradually over 5 to 10 seconds and maintain for a period of one minute.
4. Record results.

PASS/FAIL CRITERIA

Axial Force Test

Application of the force shall not result in removal or loosening of the handle, knob, grip, or the like for one minute.

Handle Strength Test

The handle shall support the test weight for one minute.

23 119-TM-N12: TEST METHOD FOR SPACINGS OF INTERNAL PARTS AND ENCLOSURES

PURPOSE

This test method is to determine that creepage distances, clearance, and thickness of insulation meet the required values.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 2.9. Creepage distances, clearances, and distances through insulation.

TEST EQUIPMENT

- IEC test finger
- Chatillon force gauge or equivalent
- Conductive foil, if required
- Calipers
- Micrometer
- Optical Comparator with metric reticle

TEST PROCEDURE

1. Apply conductive foil, if required.
2. Apply a 10 N force to the internal parts, attempting to reduce the clearances, while taking measurements.
3. Apply a 30 N force using the IEC rigid test finger to the outside of conductive enclosures, attempting to reduce the clearances, while taking measurements.
4. Measure and record spacing involved.

PASS/FAIL CRITERIA

The clearance values shall not be less than those specified in Tables 9, 10, 11. The creepage distance shall not be less than those specified in Table 12, minimum thickness through supplementary or reinforced insulation shall be 0.4 mm.

Table 9: Minimum Clearances for Insulation in Primary Circuits

See table on next page.

Minimum clearances for insulation in primary circuits and between primary and secondary circuits (mm) (Table III. IEC 950)

		Circuits Subject to Installation Category II (see conditions 1, 5 and 6)									
		Normal mains supply voltage ≤ 150 V (Transient Rating 1500 V)				Normal mains supply voltage > 150 V ≤ 300 V (Transient Rating 2500 V)				Normal mains supply voltage > 300 V ≤ 600 V (Transient Rating 4000 V)	
Insulation working voltage, up to and including		Pollution degrees 1 and 2		Pollution degree 3		Pollution degrees 1 and 2		Pollution degree 3		Pollution degrees 1, 2, and 3	
peak or dc	rms (sinusoidal)	Op	B/S	Op	B/S	Op	B/S	Op	B/S	Op	B/S
71	50	0.4	1.0 (0.7)	1.0	1.3 (1.0)	1.0	2.0 (1.7)	1.3	2.0 (1.7)	2.0	3.2 (3.0)
210	150	0.4	1.0 (0.7)	1.0	1.3 (1.0)	1.0	2.0 (1.7)	1.7	2.0 (1.7)	2.0	3.2 (3.0)
420	300	Op 1.7 B/S 2.0 (1.7)								2.5	3.2 (3.0)
840	600	Op 3.0 B/S 3.2 (3.0)									
1,400	1,000					Op/B/S 4.2					
2,800	2,000					Op/B/S 8.4					
7,000	5,000					Op/B/S 17.5					
9,800	7,000					Op/B/S 25.0					
14,000	10,000					Op/B/S 37.0					
28,000	20,000					Op/B/S 80.0					
42,000	30,000					Op/B/S 130.0					

Conditions applicable to Table 9

1. This table applicable to equipment that will not be subject to transients exceeding installation Category II according to IEC Publication 664. The appropriate transient voltage ratings are given in parentheses at the top of each supply voltage column. Where higher transients are possible, additional protection might be necessary in the mains supply to the equipment or to the installation.
2. The values in the table are applicable to operational (OP), basic (B) and supplementary (S) insulation.
3. For working voltages up to and including 840 V peak or dc, the minimum clearances for reinforced insulation are double the values in the table for basic or supplementary insulation.

   For working voltages above 840 V peak or dc up to and including 1,400 V peak or dc, the minimum clearance for reinforced insulation is 6.4 mm.

   For working voltages above 1,400 V peak or dc, the minimum clearances for reinforced insulation are the values in the table for basic or supplementary insulation.
4. The values in parentheses are applicable only where manufacturing is subject to a formal quality control program. In particular, double and reinforced insulation shall be subject to 100% electric strength testing.
5. For basic, supplementary and reinforced insulation, all parts of the primary circuit are assumed to be at not less than the norminal supply voltage with respect to earth.
6. For working voltages between 2,800 V peak or dc and 42,000 V peak or dc, interpolation may be used between the nearest two points.
7. For an air gap serving as reinforced insulation between a part at a hazardous voltage and an accessible conductive part of the enclosure of floor standing equipment or the non-vertical top surface of desk top equipment, the clearance shall be not less than 10 mm.
8. For primary circuits where the repetitive peak voltage developed within the circuit exceeds the peak value of the supply voltage, additional clearances determined from Table 10 shall be added.

Table 10: Additional Clearance Distances for Primary Circuits

See table on next page.

Additional clearance distances for primary circuits with repetitive peak voltages exceeding the peak value of the suply voltage *(Table IIIa. IEC 950)*

Nominal mains supply voltage not more than 150 V				Norminal mains supply voltage over 150 V and not more than 300 V		Additional clearance in mm to be added to minimum clearance from Table III for operational, basic and supplementary insulation; and double this value for reinforced insulation
Pollution degrees 1 and 2		Pollution degrees 3		Pollution degrees 1, 2, and 3		
Maximum repetitive peak voltage V		Maximum repetitive peak voltage V		Maximum repetitive peak voltage V		
210	(210)	210	(210)	420	(420)	0
298	(290)	294	(300)	493	(497)	0.1
386	(370)	379	(390)	567	(574)	0.2
474	(450)	463	(480)	640	(651)	0.3
562	(530)	547	(570)	713	(728)	0.4
650	(610)	632	(660)	787	(805)	0.5
738	(690)	716	(750)	860	(881)	0.6
826	(770)	800	(840)	933	(958)	0.7
914	(850)	—	—	1,006	(1,035)	0.8
1,002	(930)	—	—	1,080	(1,112)	0.9
1,090	(1,010)	—	—	1,153	(1,189)	1.0
—	—	—	—	1,226	(1,266)	1.1
—	—	—	—	1,300	(1,343)	1.2
—	—	—	—	—	(1,420)	1.3

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Conditions applicable to Table 10

1. The values in parentheses are applicable to the voltage across basic, supplementary or reinforced insulation only where manufacturing is subject to a formal quality control program. In particular, double and reinforced insulation shall be subject ot 100% electric strength testing.
2. The values in parentheses are applicable to the voltage across operational insulation without the 100% electric strength testing.
3. The total clearances obtained by use of Table 10 lie between the values required for homogeneous and inhomogeneous fields. As a result, they may not assure conformance with the appropriate electric strength test in case of fields which are substantially inhomogeneous.

Table 11: Minimum Clearances in Secondary Circuits

See table on next page.

Minimum clearances in secondary circuits (mm) *(Table IV IEC 950)*

Insulation working voltage, up to and including		Circuits subject to Installation Category I (see condition 7)					Circuits not subject to transient overvoltage; pollution degree 1 and 2 only (see condition 6)
		Normal mains supply voltage ≤ 150 V (Transient Rating 800V)		Normal mains supply voltage > 150 V ≤ 300 V (Transient Rating 1500 V)		Normal mains supply voltage > 300 V ≤ 600 V (Transient Rating 2500 V)	
peak or dc	V rms (sinusoidal)	Pollution degrees 1 and 2	Pollution degree 3	Pollution degrees 1 and 2	Pollution degree 3	Pollution degrees 1, 2 and 3	
71	50	0.7 (0.4)	1.3 (1.0)	1.0 (0.7)	1.3 (1.0)	2.0 (1.7)	0.4
140	100	0.7 (0.6)	1.3 (1.0)	1.0 (0.7)	1.3 (1.0)	2.0 (1.7)	0.7 (0.6)
210	150	0.9 (0.6)	1.3 (1.0)	1.0 (0.7)	1.3 (1.0)	2.0 (1.7)	0.9 (0.6)
280	200	1.4 (1.1)	1.4 (1.1)	1.4 (1.1)	1.4 (1.1)	2.0 (1.7)	1.1
420	300	1.9 (1.6)	1.9 (1.6)	1.9 (1.6)	1.9 (1.6)	2.0 (1.7)	1.4
700	500	2.5	2.5	2.5	2.5	2.5	2.5
840	600	3.2	3.2	3.2	3.2	3.2	3.2
1,400	1,000	4.2	4.2	4.2	4.2	4.2	4.2
2,800	2,000	8.4	8.4	8.4	8.4	8.4	8.4
7,000	5,000	17.5	17.5	17.5	17.5	17.5	17.5
9,800	7,000	25	25	25	25	25	25
14,000	10,000	37	37	37	37	37	37
28,000	20,000	80	80	80	80	80	80
42,000	30,000	130	130	130	130	130	130

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Conditions applicable to Table 11

1. The values in the table are applicable to operational, basic, and supplementary insulation.
2. For working voltages up to and including 420 V, the minimum clearance for reinforced insulation shall be double the values in the table.

   For working voltages above 420 V up to and including 1,400 V, the minimum clearance for reinforced insulation shall be the values in the table.

   Condition 7 of Table II shall also apply.
3. The values in parentheses are applicable to basic, supplementary or reinforced insulation only where manufacturing is subject to a formal quality control program. In particular double and reinforced insulation shall be subject to 100% electric strength testing.
4. The values in parentheses are applicable to operational insulation without the 100% electric strength testing.
5. The voltages between 2,800 V and 42,000 V, interpolation may be used between the nearest two points.
6. The values are applicable to d.c. secondary circuits which are reliably connected to earth and have capacitive filtering which limits the peak-to-peak ripple to 10% of the d.c. voltage.
7. Secondary circuits will normally be installation Category I when the primary is installation Category II. A floating secondary circuit shall be subject to the requirements for primary circuits in Table 9 unless separated from primary circuits by an earthed metal screen.
8. External signal cables should be prevented from introducing into secondaary circuits transients that exceed the applicable transient overvoltage limit, where they might result in a hazard.

Table 12: Minimum Creepage Distances (mm)

See table on next page.

Minimum creepage distances (mm) *(Table V IEC 950)*

Working voltage up to and including V rms or dc	Operational, basic and supplementary insulation							
	Pollution degree 1	Pollution degree 2			Pollution degree 3			
	Material group I, II, IIIa, and IIIb	Material group I	II	IIIa IIIb	Material group I	II	IIIa IIIb	
50	Use the appropriate clearance from Table III or Table IV	0.6	0.9	1.2	1.5	1.7	1.9	
100		0.7	1.0	1.4	1.8	2.0	2.2	
125		0.8	1.1	1.5	1.9	2.1	2.4	
150		0.8	1.1	1.6	2.0	2.2	2.5	
200		1.0	1.4	2.0	2.5	2.8	3.2	
250		1.3	1.8	2.5	3.2	3.6	4.0	
300		1.6	2.2	3.2	4.0	4.5	5.0	
400		2.0	2.8	4.0	5.0	5.6	6.3	
600		3.2	4.5	6.3	8.0	9.6	10.0	
1,000		5.0	7.1	10.0	12.5	14.0	16.0	

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Conditions applicable to Table 12

1. For reinforced insulation, the values for creepage distances are twice the values in the table for basic insulation.
2. If the creepage distance derived from Table 12 is less than the applicable clearance from Table 9 or Table 13 as appropriate, then the value for that clearance shall be applied as the value for the minimum creepage distance.

Material group I	600 $\leq$ CTI (Comparative Tracking Index)
Material group II	400 $\leq$ CTI < 600
Material group IIIa	175 $\leq$ CTI < 400
Material group IIIb	100 $\leq$ CTI < 175

   The CTI rating refers to the value obtained in accordance with Method A, IEC Publication 112: Method for Determining the Comparative and the Proof Tracking indices of Solid insulating Materials under Moist Conditions.
3. For working voltages of 127,208 and 415 V, creepage distances corresponding to 125,200 and 400 V may be used.
4. Minimum creepage distances equal to the applicable clearance may be used for glass, mica, ceramic or similar materials.

24 119-TM-N13: TEST METHOD FOR EQUIPMENT MOUNTING

PURPOSE

This test method is to verify that equipment intended for mounting on a surface other than on top of a horizontal surface is suitable when mounting in accordance with its instructions.

REQUIREMENT

This method tests for compliance to UL 1950 requirements, clause 4.1.5 Equipment Mounting.

TEST EQUIPMENT

- Three 50-pound bars of steel
- Three 10-pound bars of steel
- Electric hoist
- Alternately, a force gauge capable of applying 800 N
- Installation instructions

TEST PROCEDURE

1. Weigh the equipment under test.
2. Mount the equipment under test as described in the installation instructions.
3. Apply a force equal to 3 times the weight of the equipment downward for 1 minute at a point that is most likely to result in a failure of the mounting means. If the equipment is likely to be used on a horizontal working surface, the force shall be no less than 800 N.

PASS/FAIL CRITERIA

There shall be no adverse effect to the mounting surface or mounting means that increases the risk of fire, electric shock, hazardous energy level, or injury to persons.

25 119-TM-N14: TEST METHOD FOR GROUNDING

PURPOSE

This test method is to determine that the resistance of the connection between the earthing terminal or earthing contact and parts required to be earthed does not exceed 0.1 ohm.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 2.5.11 Provisions For Protective Earthing and Appendix C2 Safety isolating transformers.

Additional Requirement for CSA—Passing CSA's requirement exceeds IEC 950 requirements and therefore assures passage of both requirements.

When passing a 50- or 60-Hz test current from a part to be grounded to the earth terminal, for a period specified as in Table 13, the potential drop between the two shall not be greater than 4 volts.

Table 13: Duration of Impedance Test Current

Fusing of Branch Circuit Required for Equipment A	Time in Minutes
0-30	2
31-60	4
61-100	6
101-200	8
201 and over	10

The following test currents are used for the voltage measurement.

a. For cord-connected equipment, twice the rating of the attachment plug cap, but not less than 30 amperes

b. For equipment for permanent connection to the supply, the rating of the fuse that would be required for the branch circuit to which the equipment would be connected, up to 250 amperes

c. For equipment for permanent connection to the supply, which would require a branch circuit fused at over 250 amperes, 500 amperes

There shall not be any melting of any metal in the bond, nor heating or burning, which is likely to create a fire hazard.

TEST EQUIPMENT

- Isolating transformer with a 12 volt, 25 amp secondary output
- Autotransfomer
- Alternate: 25 ampere 12 volt power source (instead of 1 and 2 above)
- Ac voltmeter
- Ac clamp-on current meter or current shunt

TEST PROCEDURES

1. Set the voltage source to zero.
2. Plug the primary of the isolating transformer into the voltage source.
3. Place one side of the output winding on the earth ground connection.
4. Place (-) probe of the ac voltmeter at this point.
5. Place the other side of the transformer winding output to the point to be measured.
6. Connect (+) probe of the ac meter at this point.
7. Place ac clamp-on meter or current shunt on the lead from step 4.
8. For the test current, use:
   - i Value specified by the Product Safety Engineer, or if not specified
   - ii Primary circuit fuse or circuit breaker rating multiplied by 1.5, if less than 25 amps; or
   - iii 25 amps
9. Turn on the voltage source and gradually increase the voltage while reading current measurement from the clamp-on meter.
10. Once the calculated test current has been reached, maintain for one minute.
11. Record the voltage reading from the ac meter.
12. Turn the voltage source to zero, then turn off.
13. Divide the voltage reading by the test current to determine the impedance.
14. Select the next test point and repeat steps 5 through 13.

For CSA

1. Set the voltage source to zero.
2. Plug the primary of the isolating transformer into the voltage source.
3. Place one side of the output winding on the earth ground connection.
4. Place (-) probe of the ac voltmeter at this point.
5. Place the other side of the transformer winding output to the point to be measured.
6. Connect (+) probe of the ac meter at this point.
7. Place ac clamp-on meter or current shunt to the lead from step 4.
8. Multiply two times the current rating of the attachment plug cap for the equipment under test.
9. Turn on the voltage source and gradually increase the voltage while reading current measure from the clamp-on meter.
10. Once the calculated test current has been reached, maintain for the time specified per Table 13.
11. Record the voltage reading from the ac meter.
12. Turn the voltage source to zero, then turn off.
13. Divide the voltage reading by the test current to determine the impedance.

14. Select the next test point and repeat steps 5 through 13.

PASS/FAIL CRITERIA

The resistance of the connection between the earthing terminal or earthing contact and parts required to be earthed shall not exceed 0.1 ohm.

For CSA

a. For test currents up to 500 A, the measured potential drop shall not exceed 4 V;

b. For equipment that requires branch circuit fusing over 250 A, the measured potential drop multiplied by the required fusing and divided by 250 shall not exceed 4 V; and

c. There shall be no melting of any metal in the bond, and no heating or burning, which is likely to create a fire hazard.

26 119-TM-N17: TEST METHOD FOR ELEVATED TEMPERATURE TESTING

PURPOSE

This test method is to verify that materials, other than metal, used in enclosures can withstand high ambient temperatures without being damaged.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clauses 4.2.6 Mechanical Strength and Stress Relief, and 4.2.7.

This test may be waived due to examination of the equipment or of available data.

TEST EQUIPMENT

- Air circulating oven capable of maintaining temperatures within ± 2 K
- IEC test finger
- Chatillon force gauge or a suitable weight

TEST PROCEDURE

1. Place a sample of the complete equipment or of the complete enclosure with supporting framework in an air-circulating oven set at 70°C ± 2 K or 10 K higher than the maximum temperature attained during the 119-TM-E4 testing, whichever is higher.
2. After seven hours in the oven, remove the sample and allow to cool to room temperature.
3. Once cooled, inspect the sample for cracks, warping, or other deterioration.
4. Apply the test finger to any areas that show signs of warping, cracks, or other deterioration and record results.
5. If a strain relief is used, subject the cord to a pull of 156 N for a period of one minute and record results.
6. In case of doubt, supplementary or reinforced insulation shall be subjected to an electric strength test (119-TM-E7).

PASS/FAIL CRITERIA

a. There shall be no resultant cracks or openings that do not comply with Test 119-TM-N1.

b. There shall be no distortion that results in the reduction of spacings below the minimum values stated in Test 119-TM-N12.

c. There shall be no signs of interference with the operation of safety features such as thermal cutouts, overcurrent protection devices, or interlocks.

   Damage to finish, dents, and chips that do not adversely affect safety or protection against water, cracks not visible to the naked eye, and surface cracks in fiber-reinforced moldings and the like, is acceptable.

d. There shall be no damage to protective earthing paths that results in failure of Test 119-TM-N14.

e. There shall be no damage to supplementary or reinforced insulation that results in failure of Test 119-TM-E7.

f. There shall be no damage to strain reliefs that results in failure of Test 119-TM-N18.

27 119-TM-N18: TEST METHOD FOR STRAIN RELIEFS

PURPOSE

This test method is to determine that mechanical stress on the supply cord, including rotation, will not be transmitted to terminals, splices, or internal wiring.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clauses 2.5.9 Provisions for protective earthing, 3.2.5 Supply Connection, 3.2.7, and 3.3.2.

TEST EQUIPMENT

- Chatillon force gauge or equivalent
- Sling for power cord
- Torque wrench
- Stop watch or watch with sweep second hand

TEST PROCEDURES IEC Clause 3.2.5

1. Determine the pull and torque values required per Table 14.

Table 14: IEC Table IX: Strain Relief Forces

Mass (M) of Equipment kg (lb)	Pull N (kgf, lbf)	Torque Nm (ft lbs)
$M \leq 1$ (2.2)	30 (3.1, 6.7)	0.1 (.07)
1 (2.2) < $M \leq 4$ (8.8)	60 (6.1, 13.5)	0.25 (.18)
4 (8.8) < M	100 (10.2, 22.5)	0.35 (.26)

2. Attach a sling to the power cord.
3. Apply a pull of the appropriate value to the cord for one second.
4. Repeat step 3 for a total of 25 applications of the pull.
5. Record the results.
6. Immediately after steps 4 and 5, apply the torque as required per Table 14 for a period of one minute.
7. Record the results.

IEC Clause 3.2.7

NOTE

If the cord guard is a temperature-sensitive material, conduct this test at 23 ± 2°C.

1. Place the equipment under test so the cord projects at a 45 degree angle when the cord is free from stress.
2. Attach a mass (or use Chatillon force gauge) equal to $10 \times D^2$ grams to the free end of the cord, D being, in millimeters, the overall diameter of, or for flat cords, the minor overall dimension of, the cord delivered with the equipment.

3. Immediately after the mass has been attached, measure the radius of curvature of the cord.

IEC Clause 3.3.2

1. Apply a 5 N (1.1 lb) pull to the connection for 1 minute.
2. Verify the temperature rise of the connection does not exceed the values in 119-TM-E4.

PASS/FAIL CRITERIA

IEC Clause 3.2.5

a. The longitudinal displacement is no more than 2 millimeters.

b. There shall be no appreciable strain at the connections.

c. There shall be no reductions in spacings below acceptable limits when verified by 119-TM-N9.

For IEC Clause 3.2.7

The radius of curvature of the cord shall nowhere be less than 1.5 D.

For IEC Clause 3.3.2

a. The connectors shall not break away.

b. The temperature of the connector shall not exceed the values in 119-TM-E4.

28 119-TM-N19: TEST METHOD FOR SHARP EDGES

PURPOSE

This test method is to demonstrate that all exposed edges, corners, or projections are not sharp enough to cause injury to persons during intended use or operator maintenance.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 4.1.3 Mechanical Hazards.

TEST EQUIPMENT

- Technical Engineering Service Model 20 or Model 50 Sharp Edge Tester
- Tape refills made up as 3 layers as follows:
  - — Inner layer indicating tape = 3M Type 4516
  - — Middle layer sensing tape = 3M Type 4432
  - — Outer layer sensing tape = Tuck Type 43-3

TEST PROCEDURE

1. Calibrate the tester in accordance with the instructions from the manufacturer using a 6.7 N force applied to the center of the head.
2. Cover the head with the three layers of tape in the order described above. Apply each tape over approximately 180 degrees of the circumference of the test head to prevent stretching of the tape. Do not stretch the tapes when positioning them on the head.
3. Position the center of the tape-covered head of the sharp edge tester on the edge to be tested so that the arm of the tester is between stops and so that the tape covered head exerts a 6.7 N force on the edge.
4. Move the tester along the edge a distance of 50 mm and then back to its starting position without removing the tester from the edge. The total distance of engagement between the edge and the tape-covered head is not to exceed 100 mm. The time of travel is not to take longer than five seconds nor less than two seconds.

   Exception: An edge less than 50 mm long shall be tested for a distance of twice its length. Example, for an edge 40 mm long, the tester is to be moved along its length and back to the starting position so that the total distance of engagement between the edge and tester is 80 mm.
5. Examine the tape-covered head to determine whether or not penetration has occurred through the two sensing layers. If penetration has occurred through the two sensing layers, the black indicating tape will be visible through the resulting cut.

PASS/FAIL CRITERIA

The application of the sharp edge tester shall not result in a cutting through of the two outer layers of the sensing tape.

29 119-TM-N20: TEST METHOD FOR PRINTED-WIRING BOARD COATINGS

PURPOSE

This test method is to determine that coatings applied to allow reduction of creepage and clearance distance on printed-wiring boards are of sufficient quality to ensure that the reduced creepage and clearance distances are protected.

REQUIREMENTS

This method tests for compliance to IEC 950 requirements, clauses 2.9.5, 2.9.6, 2.9.7, and 2.9.8 Printed Circuit Wiring.

TEST EQUIPMENT

- Air-circulating heating and cooling oven
- Wave-soldering machine and other associated board assembly equipment
- Three test boards
- Hardened steel pin mountable on a force gauge, the end of the pin having the form of a cone with a top angle of 40 degrees, its tip being rounded and polished with a radius of 0.25 ± 0.02 mm
- Force gauge capable of measuring 10 ± 0.5 N

TEST PROCEDURE

Printed-Wiring Board Coatings

The subject boards must have been processed through the full sequence of manufacturing processes, including soldering, cleaning, and similar steps. If different processes are used, additional boards must be tested.

1. Subject Sample 1 to the following 30-day sequence of temperature cycles.

   68 hours at 100°C ± 2 K
   1 hour at 25°C ± 2 K
   2 hours at 0°C ± 2 K
   1 hours at 25°C ± 2 K

   Repeat 10 times.

2. Subject Sample 2 to a temperature of 130°C ± 2 K for 1000 hours (42 days).
3. Following the thermal conditioning, subject Samples 1 and 2 to the humidity treatment and dielectric strength test of 119-TM-E7.

   The humidity treatment shall be carried out for 48 hours in a cabinet or room containing air with a relative humidity of 91% to 95%. The temperature of the air, at all places where samples can be located, shall be maintained within 1 degree of any convenient value T between 20°C and 30°C such that condensation does not occur. During this treatment the component or subassembly shall not be energized.

   Before the humidity treatment the sample shall be brought to a temperature between T°C and (T + 4)°C.

4. With the hardened steel pin, scratches shall be made across five pairs of conducting parts and the intervening separations at points where the separations will be subjected to the maximum potential gradient during the tests.

5. Scratch the sample by drawing the pin along the surface in a plane perpendicular to the conductor edges at a speed of 20 ± 5 mm/s. The pin shall be so loaded that the force exerted along its axis is 10 ± 0.5 N. The scratches shall be at least 5 mm from the edge of the specimen.
6. Following the scratches, subject Sample 3 to the dielectric strength test of 119-TM-E7.
7. Inspect all samples for pinholes, bubbles, breakthrough, or penetrations of the coating.

Hermetically Sealed Assemblies

1. For transformers, where the insulation is relied upon for safety, apply a voltage of 500 Vrms, 50 to 60 Hz, between windings during step 2.
2. Subject a sample to the following 30-day sequence of temperature cycles.

   68 hours at T°C ± 2 K (minimum 85°C)
   1 hour at 25°C ± 2 K
   2 hours at 0°C ± 2 K
   1 hour at 25°C ± 2 K

   Repeat 10 times.

   Where T is the highest temperature of the assembly measured under normal conditions; or, for transformers, the highest winding temperature measured under normal conditions plus 10 K.
3. Following the thermal conditioning, subject the sample to the humidity treatment (two days) and dielectric strength test of 119-TM-E7.

POTTED ASSEMBLIES

1. For transformers, where the insulation is relied upon for safety, apply a voltage of 500 Vrms, 50 to 60 Hz, between windings during step 2.
2. Subject a sample to the following 30-day sequence of temperature cycles.

   68 hours at T°C ± 2 K (minimum 85°C)
   1 hour at 25°C ± 2 K
   2 hours at 0°C ± 2 K
   1 hour at 25°C ± 2 K

   Repeat 10 times.

   Where T is the highest temperature of the assembly measured under normal conditions; or, for transformers, the highest winding temperature measured under normal conditions plus 10 K.
3. Following the thermal conditioning, subject the sample to the humidity treatment (two days) and dielectric strength test of 119-TM-E7.
4. Inspect any encapsulant for cracks, shrinkage, loosening, and voids.

PASS/FAIL CRITERIA

The samples shall show no evidence of pinholes, bubbles, breakthroughs, or penetrations of the coating.

Encapsulants shall not show evidence of cracks, shrinkage, loosening, or voids.

The samples shall withstand the dielectric strength test of 119-TM-E7 without breakdown.

30 119-TM-N21: TEST METHOD FOR THERMOPLASTIC MOUNTINGS OF HAZARDOUS LIVE PARTS

PURPOSE

This test method is to determine that thermoplastic parts on which parts of hazardous voltage are directly mounted, are resistant to abnormal heat.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 5.4.10 Abnormal Tests, Thermoplastic Parts.

The tests described below are performed by the Materials Research Lab (MCESS) in MLO5-1 or other facility approved by Corporate Product Safety and Regulations.

TEST EQUIPMENT

- IEC ball pressure test device
- Air-circulating oven capable of maintaining temperatures within ± 2 K
- Pan of water at room temperature large enough to immerse sample
- Optical comparator and graticule with millimeter scale

TEST PROCEDURE

1. Place the sample horizontally in an air-circulating oven set at 125°C ± 2 K or 40 K higher than the maximum temperature attained during the testing of 119-TM-E4, whichever is higher.
2. Place the IEC ball pressure test device on the part to be tested.
3. After one hour in the oven, remove the ball pressure test device from the sample and then remove from the oven.
4. Cool the sample to room temperature within 10 seconds by immersion in cold water.
5. Measure and record the diameter of the impression caused by the ball pressure apparatus.

PASS/FAIL CRITERIA

The diameter of the impression made by the ball pressure test device shall not exceed 2 millimeters.

31 119-TM-N22: TEST METHOD FOR IGNITION THROUGH BOTTOM PANEL OPENINGS—HOT FLAMING OIL

PURPOSE

This test method is to determine that nonstandard bottom panel construction is capable of preventing flaming material from causing a fire outside the unit.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, Appendix A5, Hot Flaming Oil Test.

TEST EQUIPMENT

- Test bench with ventilation hood; ventilation hood must be draft free and have barriers to prevent splattering oil from splashing out of hood
- Metal ladle, 63.5 mm in diameter with pouring lip and long handle
- Heat resistant gloves
- Number 2 fuel oil; oil with a density between 0.845 g/ml and 0.865 g/ml, a flash point of 43.5°C to 93.5°C, and an average calorific value of 38 Mj/l
- Bunsen burner with supply of technical grade methane gas
- Bleached cheesecloth approximately 26 to 28 square meters per kilogram mass (14 to 15 square yards per pound) and a count of 13 $\times$ 11 threads per centimeter (32 $\times$ 28 threads per inch)
- Ring stands or other adjustable means to support the specimen under test
- Stopwatch or watch with sweep second hand
- Shallow, flatbottom pan
- A sample of the complete, finished bottom panel on perforated insulation barrier material supported in a horizontal position

TEST PROCEDURE

NOTE

This procedure shall be performed only in the Materials Research Lab.

1. Place a single layer of cheesecloth in a flatbottom pan. The cheesecloth should be large enough to catch any oil that falls through the bottom openings, but not so large as to catch runoff from the sides of the part under test.
2. Position the sample of bottom construction to be tested on ring stands or other adjustable supports at a height of 50 mm above the cheesecloth.
3. Fill the ladle with 10 cubic centimeters of No. 2 fuel oil.
4. Ignite the fuel oil and let it burn for 60 seconds.
5. Pour the flaming oil, in a steady stream, at a rate of approximately 1 cubic centimeter per second onto the center of the pattern of openings from a height of 100 mm.
6. Observe whether the oil ignites the cheesecloth and record the results.
7. Wait five minutes and repeat steps 1 through 6 using clean cheesecloth.
8. Repeat step 7 (total of three tests).

PASS/FAIL CRITERIA

The cheesecloth must not ignite during any of the three pourings.

32 119-TM-D1: TEST METHOD FOR PERMANENCE OF MARKING

PURPOSE

This test method is to test the adhesion and resistance to defacement of the product label(s).

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 1.7.15 Marking and Instructions.

TEST EQUIPMENT

- Label samples
- Piece of cloth
- Water at room temperature
- Petroleum spirit—K1 (kerosene)

TEST PROCEDURE

1. Rub label for 15 seconds with a piece of cloth soaked with water.
2. Rub label for 15 seconds with a piece of cloth soaked with petroleum spirit.
3. Record results.

PASS/FAIL CRITERIA

The sample label shall:

a. Demonstrate good adhesion (that is, it should not be able to be removed easily)

b. Have no curled edges

c. Be legible

33 119-TM-D2: TEST METHOD FOR ABNORMAL OPERATION AND FAULT TEST

PURPOSE

This test method is to determine if a machine remains safe during abnormal operation and after the occurrence of a single fault and the consequential damage resulting from that fault. It is not required that the equipment remain functional either during or after the test, only that it remain safe for an operator within the meaning of this standard.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clauses 1.3.1, 2.7.3, 4.3.1, 4.3.2, 4.3.24, Construction Details, 5.4.4, 5.4.5, 5.4.6, 5.4.7, 5.4.8, 5.4.9, Abnormal Operation and Fault Operations, and Appendix L, Thermal Controls.

TEST EQUIPMENT REQUIRED

- Cord set with fuseholder in the earth ground lead
- Three-amp fuse
- Thermocouples and data logger or similar thermal meter calibrated for 30-AWG iron-constantan thermocouples or equivalent
- Thompson bridge or equivalent milliohmmeter (when needed for winding temperatures)
- Autotransformer
- Voltmeter
- Resistive or active loads
- White tissue paper
- Cotton mesh cheesecloth, approximately 1.2 $\times$ 1.1 threads/mm (32 $\times$ 28 threads/in)
- Softwood board
- HI-POT tester
- Shorting switch and leads
- Thermal epoxy or duct tape

TEST PROCEDURE

For CSA testing the equipment shall be connected to earth ground through a 3-amp fuse.

Parts of the equipment other than motors and transformers shall be checked by simulating faults. The equipment, circuit diagrams, and component specification should be examined to determine those fault conditions that might reasonably occur. In particular, testing should include shorting of capacitors and shorting and opening of rectifiers as well as other semiconductor devices. These are applied in turn and one at a time. Simulated circuits may be used for this test.

NOTE

The engineer may specify testing to be done with the product fuse bypassed (or highest fuse rating possible) and that the product be tested on a 30 amp circuit in order to eliminate the need for the fuse warning label required by *DEC STD 178-3 Digital Marking Requirements for Completed Products Intended to be Sold*, subhead 11.12.1.

1. If in doubt that this test will cause a fire, place the equipment on a softwood board that is covered with a single layer of white tissue paper and the equipment in turn covered with a single layer of cheesecloth.
2. Connect thermocouples as required.
3. Turn on the equipment under test and operate at the rated voltage or at the upper limit of the rated voltage range, until a normal-operating state is reached.
4. Insert or cause the fault. See Table 16 for guidelines. (If the product does not comply with IEC 950, clauses 4.4.2 and 4.4.3, all components must be faulted)
5. Continue the test as long as necessary to establish steady conditions, even when a fault is obvious to the operator.
6. Monitor temperatures of supply transformer insulation and supplementary or reinforced insulation that may overheat during test.
7. Perform test 119-TM-E7, Test Method for Dielectric Strength after the insulation has cooled to room temperature, but without prior environmental conditioning.
8. Record worst-case temperatures, any indications of flame or molten metal, glowing or flaming of tissue paper or cheesecloth, description of failure made, condition of enclosure, and result of HI-POT test.
9. Perform two tests at the extremes of the rated voltage range, as in Table 15. If more than one power supply range is specified for the equipment, the two tests are performed at each of the rated voltage ranges.
10. If the circuit is interrupted by the opening of a component, repeat steps 3 through 8 two more times (3 tests total). The two tests in step 9 count towards this total.

Table 15: Supply Voltage Test Points

Nominal	Lower	Upper
101	90	110
120	104	128
202	180	220
208	180	220
220	190	235
230	200	244
240	208	256
380	331	407
400	346	422
415	360	443

Table 16: Fault Insertion

Component	Fault to be Inserted
Components	
Diodes	Diodes in the primary circuit and power rectifiers in the secondary circuit shall be tested by short circuiting and open circuiting their terminals.
Capacitors	Electrolytic capacitors shall be tested by short or open circuiting their terminals.
Semiconductors	Semiconductors, such as switching transistors and the like, that are capable of causing excessive dissipation or faults in other components shall be shorted or open circuited.
Resistors	Resistors shall be open circuited.
Battery circuits	For all rechargeable batteries, short or open components that may cause forced charging or forced discharge. In addition, for lithium and similar batteries that are not rechargeable, short or open components that may cause forced discharging. If lithium or similar batteries can be installed with reverse polarity, test for that condition.
Primary circuit components	Test other components judged necessary by the Product Safety Engineer.
Power Supply	
Power supply overloads and short circuits	The output terminals of a power supply are loaded to the maximum-rated power output load. The power supply is also tested under the condition of short circuiting the output terminals.
Operator accessible circuits and connectors	Safe operation of the equipment is checked at the maximum continuous power-operating point and the maximum continuous current point of operator accessible connectors and printed-wiring board connectors. For the purposes of testing, the trip point of overcurrent protective devices is considered to be 110 percent of their current rating. Connections are also subjected to short circuit.
Three-Phase Circuits	
Phase loss	Three-phase products shall be tested under both starting and running conditions for safe operation with one of the three phases disconnected. Phase loss detection circuits are not bypassed as part of the test.
Phase rotation	Three-phase motors and other three-phase equipment sensitive to phase rotation shall be tested for safety with the phase rotation reversed (two wires switched). Rotation detection circuits shall not be bypassed, but consideration shall be given to servicing errors.

Table 16 (Cont.): Fault Insertion

Component	Fault to be Inserted
Mechanical Considerations	
Air or heat flow blockage	The machine is operated with blocked ventilating openings that are likely to be covered simultaneously; for example, groups of openings situated along one side or on the top of the machine. Such groups are covered in turn. The machine is operated under normal idling conditions with any protective or dust covers in place.
Restriction of mechanical movements	The mechanical movement is locked in the most disadvantageous position while the component is energized normally.
Paper jams	A paper jam that is likely to stall or overload a drive motor is simulated. Misloading (too much paper, folded, wrinkled or bunched paper, misaligned ribbon cartridges, and so forth) shall be attempted. Particular attention shall be paid to jams in high temperature areas, such as toner fusers.
Heaters	Faults in timers, switches, or drive mechanisms that allow heaters, heat lamps, or stalled materials, such as paper to overheat.
Dust covers	Operate under normal conditions with dust covers, acoustic covers, or similar protective covers in place.
Miscellaneous Faults	
High-voltage anodes	The short-circuiting of a high-voltage anode shall be performed.
Continuous energization of intermittent loads	For a component that is normally energized intermittently, a simulated fault is inserted in the drive circuit that will cause continuous energizing of the component.
Tap or switch setting errors	Multivoltage equipment with primary voltage selection means, such as switches or tapped transformers, shall be tested with the voltage applied according to Table 15 and at each voltage selection setting. **NOTE** **Digital's requirement includes the testing of voltage-selecting devices in service access areas.**
Stalled motors	Fans and blowers, motors, stepper motors, linear actuators, and the like shall be tested under stalled conditions if the tests D5 through D10 do not represent the consequential circumstances, such as lack of airflow.
Incorrect setting of knobs and levers	Operation of user accessible controls, such as knobs, levers, keys, and bars, that is not in accordance with operating instructions is performed in an attempt to discover hazardous conditions.
Thermal, position or time controls	Machines having thermostats, temperature limiters, thermal controls, position sensors, timers, and the like shall be tested with the thermal regulation or function short-circuited or overridden.
Fluid leaks	The rupture or leakage of tubing, couplings, seals, and the like carrying fluids that might leak shall be simulated.
Insulation-damaging faults	Simulate faults in any components where failure could adversely affect supplementary or reinforced insulation.
Flammability and ignition source noncompliance	When specified by the Product Safety Engineer, fault tests on all components shall be performed where ignition sources and flammable materials exist.

Table 16 (Cont.): Fault Insertion

Component	Fault to be Inserted
Insufficient Spacings	
Insufficient spacings	The Product Safety Engineer shall specify the operational insulation that must be tested due to not meeting the spacings or HI-POT requirements, if applicable. Only one location at a time is to be short-circuited. Other faults that are the direct consequence of the deliberate short circuit shall also be taken into account.
Special Tests	
Special tests	Additional tests may be specified by the Product Safety Engineer or certification agencies based on consideration of design of the equipment, circuit diagrams, and component specifications indicating fault conditions that might reasonably occur. These faults are applied in turn and only one at a time.

PASS/FAIL CRITERIA

a. No emission of flame or molten metal (except solder) from the product shall occur. The cheesecloth or tissue paper shall not flame or glow.

b. Wires or printed-wiring board traces in primary circuits shall not open.

EXCEPTION

Secondary windings that exceed the temperature limits, but that become open-circuited or otherwise require replacement of the transformer, shall not constitute a failure of this test provided that no hazard is created in the meaning of this standard.

c. The enclosure should not deform in such a way as to cause noncompliance with operator access requirements.

d. If the failure of the insulation would not result in the exposure to hazardous voltages or hazardous energies, a maximum temperature of 300°C is acceptable. See Table 17 under Hazard Insulation for maximum temperature rise.

e. For equipment not complying with IEC 950 clauses 4.4.2 and 4.4.3, temperatures of insulation systems or in the transformer supplying the component under test shall not exceed those specified in Table 17 under Ignition and Flammable Material Exposure.

Table 17: Maximum Temperature Rise

Temperature Rise (K)	Hazard Insulation	Ignition and Flammable Material Exposure Insulation Material Class				
		105 (A)	120 (E)	130 (B)	155 (F)	180 (H)
DEC STD 102 Environ. Class A	268	118	133	143	158	178
DEC STD 102 Environ. Class B	260	110	125	135	150	170
DEC STD 102 Environ. Class C	250	100	115	125	140	160

NOTE

When the temperature of windings is determined using the thermocouple method, these temperatures are reduced by 10 K.

UL and CSA have no classification corresponding to Class E, but will evaluate such if requested.

f. The product shall pass the dielectric strength test.

g. If the test was concluded due to opening of an operator accessible fuse, it shall be noted in the test report and brought to the attention of the Product Safety Engineer, since labeling requirements may be affected.

h. The product shall remain safe within the meaning of *DEC STD 119-1 Digital Product Safety - Design Criteria*. If there is any question, consult with the Product Safety Engineer.

i. For CSA, the 3-amp fuse in the earth ground lead shall be intact.

34 119-TM-D3: TEST METHOD FOR SELV CIRCUITS

PURPOSE

This test method is to ensure that the product will maintain safe voltage levels on SELV circuits in the event of a failure of insulation or spacings not meeting the SELV insulation spacing requirements.

In some applications in certain countries, this test is insufficient for qualification of SELV circuits.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clauses 2.3.3, 2.3.6, 2.3.7, 2.3.9, 2.3.10 Safety Extra-Low Voltage (SELV) Circuits.

TEST EQUIPMENT

- Autotransformer
- Storage scope
- Resistive or active loads, if required
- 15 amp or larger, 250-volt double-pole switch
- Voltmeter

TEST PROCEDURE

NOTE

There is no fuse in the ground circuit for this test.

1. Perform two tests, one at the upper and one at the lower voltage, as in Table 18, Supply Voltage Test Points. If more than one power supply range is specified for the equipment, the two tests are performed at each of the supply ranges.

Table 18: Supply Voltage Test Points

Nominal	Lower	Upper
101	90	110
120	104	128
202	180	220
208	180	220
220	190	235
230	200	244
240	208	256
380	331	407
400	346	422
415	360	443

2. Monitor output levels of SELV circuits on the storage scope. If desired, the sweep circuit on the scope may be triggered by the same switch that creates the short circuit.
3. Apply the faults one at a time. This application may include, but is not limited to, the following.
   a. Short-circuit any insulation barrier not meeting the required spacing criteria
   b. Short-circuit any impedance or component separating SELV and non-SELV circuits
4. Open-circuit any impedances or regulator that loads or controls voltage down to SELV levels.
5. Record the operator accessible voltages during and following fault insertion.
6. List the failed and damaged components in the test report.
7. Repair or replace any damaged components before the next fault.

PASS/FAIL CRITERIA

The voltage of accessible parts of the SELV circuit shall not exceed:

a. 71 volts peak or 120 Vdc; and

b. 42.4 volts peak or 60 Vdc for more than 0.2 seconds

35 119-TM-D4: TEST METHOD FOR TRANSFORMER OVERLOAD/SHORT CIRCUIT

PURPOSE

This test method is to ensure that the unit, under fault conditions typical of transformer failures and overloads, cannot produce a hazard during its intended operation.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 5.4.3, Appendix C Transformers, and C1 Overload test.

TEST EQUIPMENT

- Thompson Bridge or equivalent milliohmmeter, if using rise of resistance method, or thermocouple and data logger or thermal meter calibrated for 30-AWG iron-constantan thermocouples or equivalent
- 15-amp, 250-volt switch or equivalent for fault insertion
- HI-POT tester
- Megohm meter
- Voltmeter
- Fixed or programmable loads, if required
- Thermal epoxy or duct tape
- Transfer switch for resistance bridge (optional)

TEST PROCEDURE

1. Connect bridge or thermocouple as specified by the Product Safety Engineer.
2. Perform two tests, one at the upper and one at the lower supply voltage determined from the nominal or nominal range as in Table 19. If more than one power supply range is specified for the equipment, the two tests are performed at each of the ranges.

Table 19: Supply Voltage Test Points

Nominal	Lower	Upper
101	90	110
120	104	128
202	180	220
208	180	220
220	190	235
230	200	244
240	208	256
380	331	407
400	346	422
415	360	443

3. Turn the equipment on and bring to a normal operating state.

4. Insert or cause the fault(s) described below and continue the test as long as necessary to establish steady conditions.
   - For a conventional or safety-isolating transformer, short-circuit each secondary winding in turn, with the other secondaries loaded to their specified maxima, taking into account the effect of any protection device provided.
   - For ferro-resonant and switching transformers, load each secondary winding in turn so as to obtain the maximum heating effect.
5. Measure and record temperatures as follows:
   - For external overcurrent protection or for manual reset thermal cutout, at the moment of operation
   - For current limiting transformers—after temperature has stabilized
   - For automatic reset thermal cutouts—continuous recording for 400 hours
6. Perform Test 119-TM-E7, Test Method for Dielectric Strength, without prior environmental conditioning.

PASS/FAIL CRITERIA

a. Temperatures during the test shall not exceed the limits in Table 20.

Table 20: Maximum Temperature Rise of Transformer Windings

	Insulation Material Class				
Temperature Rise (K)	105 (A)	120 (E)	130 (B)	155 (F)	180 (H)
DEC STD 102 Environment, Class A					
Protection by inherent or external impedance:	118	133	143	158	178
Protection by protective device that operates					
During the first hour	168	183	193	208	228
After first hour	143	158	168	183	203
Arithmetic average during the second hour and during the 72nd hour	118	133	143	158	178
DEC STD 102 Environment, Class B					
Protection by inherent or external impedance	110	125	135	150	170
Protection by protective device that operates:					
During the first hour	160	175	185	200	220
After first hour	135	150	160	175	195
Arithmetic average during the second hour and during the 72nd hour	110	125	135	150	170

Table 20 (Cont.): Maximum Temperature Rise of Transformer Windings

Temperature Rise (K)	Insulation Material Class 105 (A)	120 (E)	130 (B)	155 (F)	180 (H)
DEC STD 102 Environment, Class C					
Protection by inherent or external impedance	100	115	125	140	160
Protection by protective device that operates:					
During the first hour	150	165	175	190	210
After first hour	125	140	150	165	185
Arithmetic average during the second hour and during the 72nd hour	100	115	125	140	160

b. Primary windings that fuse or open are evidence that temperature rises are exceeded and constitute test failure, regardless of thermocouple or resistance temperature measurements. Fusible thermal protectors that melt do not constitute failure.

c. Secondary windings that exceed the temperature limits but that become open circuit or otherwise require replacement of the transformer shall not constitute a failure of this test, provided that no hazard is created within the meaning of this standard.

d. The product shall pass the Dielectric Strength Test (119-TM-E7).

36 TEST 119-TM-D5 TEST METHOD FOR MOTORS - LOCKED-ROTOR

PURPOSE

This test method is to test that the motor under locked-rotor conditions cannot produce a hazard during its intended operation.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 5.4.2, Appendices B1 General requirements, B2 Test conditions, B3 Maximum temperatures, and B5 Locked-Rotor Overload Test.

TEST EQUIPMENT

- Thermocouple and data logger or thermal meter calibrated for 30-AWG iron-constantan thermocouples or equivalent
- HI-POT tester
- Autotransformer (20-amp rating)
- Voltmeter
- Thermal epoxy or duct tape
- Brace to lock rotor

TEST PROCEDURE

1. Locate thermocouples on the winding, or, for totally enclosed motors, on the frame.
2. Lock rotor on the motor.
3. Connect motor to the voltage source.
4. Set the voltage source to the highest-rated voltage or at the highest voltage of the rated voltage range.
5. Turn on the voltage source.
6. Record the room ambient temperature.
7. The duration of the test shall be as follows.
   a. A motor protected by inherent or external impedance shall be operated on locked-rotor for 15 days except that testing may be discontinued when the windings of the motor, of either the open or totally enclosed type, reach a constant temperature, provided that the constant temperature is not more than specified in Table 21 for the insulation used.

Table 21: Maximum Temperature Rise of Motor Windings (IEC Table BI) (Except for Running Overload Test)

Temperature Rise (K)	Insulation Material Class				
	105 (A)	120 (E)	130 (B)	155 (F)	180 (H)
DEC STD 102 Environment, Class A					
Protection by inherent or external impedance	118	133	143	158	178
Protection by protective device that operates:					
During the first hour	168	183	193	208	228
After first hour	143	158	168	183	203
Arithmetic average during the second hour and during the 72nd hour	118	133	143	158	178
DEC STD 102 Environment, Class B					
Protection by inherent or external impedance	110	125	135	150	170
Protection by protective device that operates:					
During the first hour	160	175	185	200	220
After first hour	135	150	160	175	195
Arithmetic average during the second hour and during the 72nd hour	110	125	135	150	170
DEC STD 102 Environment, Class C					
Protection by inherent or external impedance	100	115	125	140	160
Protection by protective device that operates:					
During the first hour	150	165	175	190	210
After first hour	125	140	150	165	185
Arithmetic average during the second hour and during the 72nd hour	100	115	125	140	160

NOTES

i When the temperature of windings is determined using the thermocouple method, these temperatures are reduced by 10 K.

ii UL and CSA have no classification corresponding to Class E, but will evaluate such if requested.

b. A motor with an automatic reset protection device shall be cycled on locked-rotor for 18 days.

c. A motor with a manual reset protection device shall be cycled on locked-rotor for 60 cycles, the protection device being reset after each operation as soon as possible for it to remain closed, but after not less than 30 seconds.

d. A motor with a nonresettable protection device shall be operated until the device operates.

8. Temperatures shall be recorded at regular intervals during the first three days for a motor with inherent or external impedance protection or with an automatic reset protection device, or during the first 10 cycles for a motor with a manual reset protection device, or at the time of operation of a nonresettable protection device.
9. Perform test 119-TM-E7, Test Method for Dielectric Strength, without prior environmental conditioning at 0.6 times the specified values.

PASS/FAIL CRITERIA

a. Temperature rise measurements shall not exceed the values in Table 21.

b. The motor shall withstand the electric strength test.

c. During the test, protection devices shall operate reliably without insulation fault to the motor frame or permanent damage to the motor, including excessive deterioration of the insulation.

   Permanent damage to the motor includes:

   - Severe or prolonged smoking or flaming:
   - Electrical or mechanical breakdown of any associated component part such as a capacitor or starting relay.
   - Flaking, embrittlement or charring of insulation.

     Discoloration of the insulation is permitted, but charring or embrittlement to the extent that insulation flakes off, or material is removed when the winding is rubbed with the thumb, is not acceptable.

37 119-TM-D6 TEST METHOD FOR LOCKED-ROTOR OVERLOAD TEST FOR DC MOTORS IN SECONDARY CIRCUITS

PURPOSE

This test method is to test that the motor, under fault conditions, cannot produce a hazard during its intended operation.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 5.4.2, B2 Test Conditions, B3 Maximum Temperatures, and B7 Locked-rotor overload test for dc motors in secondary circuits.

TEST EQUIPMENT

- Power supply or simulated motor drive circuit
- Voltmeter
- Bleached 40 g/m² cotton cheesecloth
- Wrapping tissue between 12 g/m² and 30 g/m²
- Wooden board
- Thermocouple and data logger or thermal meter calibrated for 30-AWG iron-constantan thermocouples or equivalent
- Thermal epoxy or duct tape

TEST PROCEDURE

Temperature Based Test Per B7.2

1. Locate thermocouples on the winding, or for totally enclosed motors, on the frame.
2. Connect motor, with the rotor locked, to the power supply.
3. Operate the motor at its working voltage as in Table 22, with the rotor locked for 7 hours or until steady conditions are established, whichever is longer.
4. Record the highest temperatures reached.

Table 22: Working Voltage (Volts rms)

Nominal	Working (Test) Voltage
101	110
120	128
202	220
208	220
220	235
230	244
240	256
380	407
400	422
415	443

Ignition Based Test Per B7.3

1. Place the motor, with the rotor locked, on a wooden board covered with a single layer of wrapping paper, and the motor in turn covered with a single layer of cheesecloth.
2. Connect the motor, with the rotor locked, to the power supply.
3. Operate the motor at its working voltage as in Table 22 with the rotor locked for 7 hours or until steady conditions are established, whichever is longer.
4. Inspect the wrapping paper and cheesecloth for evidence of ignition.

PASS/FAIL CRITERIA

Either:

a. The temperature measurements shall not exceed the values in Table 23; or

b. There is no ignition of the tissue paper or cheesecloth.

Table 23: Permissible Temperature Limits for Motor Windings (IEC Table BI)

Temperature Rise (K)	Insulation Material Class				
	105 (A)	120 (E)	130 (B)	155 (F)	180 (H)
DEC STD 102 Environment, Class A					
Protection by inherent or external impedance	118	133	143	158	178
Protection by protective device that operates:					
During the first hour	168	183	193	208	228
After first hour	143	158	168	183	203
Arithmetic average during the second hour and during the 72nd hour	118	133	143	158	178
DEC STD 102 Environment, Class B					
Protection by inherent or external impedance	110	125	135	150	170
Protection by protective device that operates:					
During the first hour	160	175	185	200	220
After first hour	135	150	160	175	195
Arithmetic average during the second hour and during the 72nd hour	110	125	135	150	170
DEC STD 102 Environment, Class C					
Protection by inherent or external impedance	100	115	125	140	160
Protection by protective device that operates:					
During the first hour	150	165	175	190	210
After first hour	125	140	150	165	185
Arithmetic average during the second hour and during the 72nd hour	100	115	125	140	160

NOTES

When the temperature of windings is determined using the thermocouple method, these temperatures are reduced by 10 K.

UL and CSA have no classification corresponding to Class E, but will evaluate such if requested.

38 119-TM-D7 TEST METHOD FOR MOTORS WITH CAPACITORS

PURPOSE

This test method is to test that the motor, under fault conditions, cannot produce a hazard during its intended operation.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 5.4.2, Appendix B1 General Requirements, B2 Test Conditions, and B3 Maximum Temperatures, B8 Tests for Motors With Capacitors.

This test is required in addition to the locked-rotor test described in 119-TM-D5.

TEST EQUIPMENT

- Thermocouple and data logger or thermal meter calibrated for 30-AWG iron-constantan thermocouples or equivalent
- Autotransformer
- Voltmeter
- Thermal epoxy or duct tape
- Brace to lock rotor

TEST PROCEDURE

1. Short-circuit or open-circuit the capacitor, whichever produces the most unfavorable condition.
2. Locate the thermocouples on the windings, or for totally enclosed motors, on the frame.
3. Lock the rotor.
4. Connect the motor to the voltage source set at rated voltage or at the highest voltage of the rated voltage range, and turn on.
5. Operate the motor until the temperature has stabilized, or until operation of fuses, thermal cutouts, motor protection devices, or the like.
6. Record the highest temperature reached.

PASS/FAIL CRITERIA

The temperature rise measurements shall not exceed the values in Table 24.

Windings that fuse or open are evidence that temperature rises are exceeded, and constitute test failure, regardless of thermocouple or resistance temperature measurements. Fusible thermal protectors that melt do not constitute failure.

Table 24: Permissible Temperature Limits For Motor Windings (IEC 950 Table BI)

Temperature Rise (K)	Insulation Material Class				
	105 (A)	120 (E)	130 (B)	155 (F)	180 (H)
DEC STD 102 Environment, Class A					
Protection by inherent or external impedance	118	133	143	158	178
Protection by protective device that operates:					
During the first hour	168	183	193	208	228
After first hour	143	158	168	183	203
Arithmetic average during the second hour and during the 72nd hour	118	133	143	158	178
DEC STD 102 Environment, Class B					
Protection by inherent or external impedance	110	125	135	150	170
Protection by protective device that operates:					
During the first hour	160	175	185	200	220
After first hour	135	150	160	175	195
Arithmetic average during the second hour and during the 72nd hour	110	125	135	150	170
DEC STD 102 Environment, Class C					
Protection by inherent or external impedance	100	115	125	140	160
Protection by protective device that operates:					
During the first hour	150	165	175	190	210
After first hour	125	140	150	165	185
Arithmetic average during the second hour and during the 72nd hour	100	115	125	140	160

NOTES

When the temperature of windings is determined using the thermocouple method, these temperatures are reduced by 10 K.

UL and CSA have no classification corresponding to Class E, but will evaluate such if requested.

39 119-TM-D8 TEST METHOD FOR THREE-PHASE MOTORS

PURPOSE

This test method is to test that the motor, under fault conditions, cannot produce a hazard during its intended operation.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 5.4.2, Appendix B1 General Requirements, B2 Test Conditions, B3 Maximum Temperatures, and B9 Three-Phase Motors.

The test is performed in addition to the locked-rotor test described in 119-TM-D5.

TEST EQUIPMENT

This is the test equipment required for this test.

- Thermocouple and data logger or thermal meter calibrated for 30-AWG iron-constantan thermocouples or equivalent
- Autotransformer
- Voltmeter
- Thermal epoxy or duct tape

TEST PROCEDURE

1. Locate the thermocouples on the windings, or for totally enclosed motors, on the frame.
2. Disconnect one phase to the motor.
3. Connect the motor (under normal load) to the voltage source set at the rated voltage or at the highest voltage of the rated voltage range and turn on.
4. Operate the motor until the temperature has stabilized, or until operation of fuses, thermal cutouts, motor protection devices, or the like.
5. Record the highest temperature reached.
6. Disconnect the other two phases in turn and test per steps 2 through 5.

PASS/FAIL CRITERIA

The temperature measurements shall not exceed the values in Table 25.

Table 25: Maximum Temperature Rise of Magnetics (IEC 950 Table BI)

Temperature Rise (K)	Insulation Material Class				
	105 (A)	120 (E)	130 (B)	155 (F)	180 (H)
DEC STD 102 Environment, Class A					
Protection by inherent or external impedance	118	133	143	158	178
Protection by protective device that operates:					
During the first hour	168	183	193	208	228
After first hour	143	158	168	183	203
Arithmetic average during the second hour and during the 72nd hour	118	133	143	158	178
DEC STD 102 Environment, Class B					
Protection by inherent or external impedance	110	125	135	150	170
Protection by protective device that operates:					
During the first hour	160	175	185	200	220
After first hour	135	150	160	175	195
Arithmetic average during the second hour and during the 72nd hour	110	125	135	150	170
DEC STD 102 Environment, Class C					
Protection by inherent or external impedance	100	115	125	140	160
Protection by protective device that operates:					
During the first hour	150	165	175	190	210
After first hour	125	140	150	165	185
Arithmetic average during the second hour and during the 72nd hour	100	115	125	140	160

NOTES

When the temperature of windings is determined using the thermocouple method, these temperatures are reduced by 10 K.

UL and CSA have no classification corresponding to Class E, but will evaluate such if requested.

Windings that fuse or open are evidence that temperature rises are exceeded, and constitute test failure regardless of thermocouple or resistance temperature measurements. Fusible thermal protectors that melt do not constitute failure.

40 119-TM-D9: TEST METHOD FOR RUNNING OVERLOAD TEST FOR DC MOTORS IN SECONDARY CIRCUITS

PURPOSE

This test method is to test that the motor, under fault condition, cannot produce a hazard during its intended operation.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 5.4.2, Appendix B1 General Requirements, B2 , B3 Maximum Temperatures, B4 Running overload test, and B6 Running Overload Test for DC Motors in Secondary Circuits.

TEST EQUIPMENT

a. Thermocouple and data logger or thermal meter calibrated for 30-AWG iron-constantan thermocouples or equivalent

b. Autotransformer

c. Thermal epoxy or duct tape

d. Eddy current brake and dynamometer or equivalent load and measuring device

e. Bleached 40 g/m^2 cotton cheesecloth, if required

f. Ammeter

g. Voltmeter

TEST PROCEDURE

Temperature Based Running Overload Test

a. Locate the thermocouples on the windings, or for totally enclosed motors, on the frame.

b. Connect the dynamometer and the eddy current brake to the motor in addition to its normal load.

c. Connect the motor to the voltage source set at the working voltage as in Table 26 and turn on.

Table 26: Working Voltage (Volts rms)

Nominal	Working (Test)
101	110
120	128
202	220
208	220
220	235
230	244
240	256
380	407
400	422
415	443

d. Operate the motor until steady conditions are established.

e. Increase the load so the current is increased in appropriate gradual steps maintaining the motor supply voltage at its original value.

f. When steady conditions are established, the load is again increased. Repeat this step until the overload protection device operates or the winding open-circuits.

g. Record the motor-windings temperature during each steady period and the maximum temperature reached.

Alternate Ignition Based Test Only For DC Motors in Secondary Circuits

a. Cover the motor with a single layer of cheesecloth.

b. Perform steps b through f of the paragraph, *Temperature Based Running Overload Test*.

c. Inspect the cheesecloth for evidence of ignition.

PASS/FAIL CRITERIA

Either:

a. The temperature measurements shall not exceed the values in Table 27; or,

b. There is no ignition of the cheesecloth.

Table 27: Permissible Temperature Limits for Running Overload Tests

Temperature Rise (K)	Insulation Material Class				
	105 (A)	120 (E)	130 (B)	155 (F)	180 (H)
DEC STD 102 Environmental Class A	108	123	133	148	168
DEC STD 102 Environmental Class B	100	115	125	140	160
DEC STD 102 Environmental Class C	90	105	115	130	150

41 119-TM-D10: TEST METHOD FOR SERIES MOTORS

PURPOSE

This test method is to test that the motor, under fault condition, cannot produce a hazard during its intended operation.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 5.4.2, Appendix B1 General Requirements, and B10 Series Motors.

TEST EQUIPMENT

- Autotransformer
- Voltmeter

TEST PROCEDURE

a. Set the voltage source at 1.3 times the motor-rated voltage.

b. Connect the motor, with the lowest possible load, to the voltage source and turn on.

c. Operate the motor for one minute and turn off.

d. Inspect for loose windings and connections and other hazards that may be a result of this test.

PASS/FAIL CRITERIA

Windings and connections shall not have worked loose and no other hazard shall have resulted due to this test.

42 119-TM-D12: TEST METHOD FOR IONIZING RADIATION (ABNORMAL AND NORMAL CONDITIONS)

PURPOSE

This test method is to measure, during normal and fault conditions, the ionizing radiation of cathode ray tube (CRT) products for conformance to country-specific radiation acts and regulations.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 4.3.12 and Appendix H Ionizing Radiation.

TEST EQUIPMENT

- Autotransformer
- Victoreen 440RF/C or equivalent radiation meter
- Switch for shorting components
- Dc power supply
- 50 kilovolts high-voltage probe
- Voltmeter

TEST PROCEDURE

1. Remove all enclosures, windows, shields, cages, and covers that are removable for servicing. If indicated by the Product Safety Engineer, tests may be repeated with specific service shields in place.
2. Connect the switch across the components selected by the Product Safety Engineer to be shorted or opened.
3. Set the autotransformer within the appropriate operating range as in Table 28 to the voltage that produces the greatest radiation or highest anode voltage for undetectable radiation.

Table 28: Operating Voltage Range

Nominal	Range
101	90-111
120	104-130
202	180-222
208	180-229
220	190-242
230	200-253
240	208-264
380	331-418
400	346-440
415	360-456

NOTE

The maximum voltage required is derived using +10% of the nominal voltage with the exception of 120 V. This maximum is a UL requirement.

4. Adjust all operator and service controls, regardless of location, for maximum X-radiation during operation without impairing the performance of the unit. Factory-sealed controls should not be readjusted. Measurements shall be taken with both minimum and maximum screen illumination.
5. Insert faults, one at a time and measure the radiation if display is usable.
6. Disconnect and drive the power input to the video circuit from a variable dc supply. Raise the voltage to just below the point where the display becomes unusable or the circuits fail, and measure the radiation.

The scan rates and patterns shall be as recommended by the meter manufacturer. A survey instrument such as the E. F. Johnson TV100 may be used for scanning, using the calibrated meter for checking indicated emission points and spot checks. The dimensions of the meter generally allow for the spacing of the detector, meaning the meter is placed in direct contact with the surface being measured.

Particular attention should be given to radiation leakage at the anode connection and where the neck joins the cone part of the tube.

PASS/FAIL CRITERIA

Radiation emission shall not produce X-radiation exceeding a dose-rate, averaged over an area of 10 centimeter squared, of 7 pA/kg (0.1mR/h) at any location 5 centimeters from the surface of the tube.

Since radiation emission is typically far below that detectable by instruments, *any measurable levels should be brought to the attention of the Product Safety Engineer*.

43 119-TM-D13: TEST METHOD FOR LIMITED POWER SOURCES

PURPOSE

This test method is to evaluate compliance of circuits to the requirements of a limited power source, including Class 2 circuits in North America.

REQUIREMENT

This method tests for compliance with IEC 950 requirements, clause 2.11.

TEST EQUIPMENT

- Adjustable resistive or programmable load appropriate to fully load the product under test.
- Autotransformer
- Voltmeter
- Ammeter that can measure ac and dc rms current
- Wattmeter (optional—avoids calculating volt-amperes)
- Low resistance test leads (12 AWG is sufficient)

TEST PROCEDURE

1. Turn on the product and connect to the worst-case voltage as in Table 29.

Table 29: Supply Voltage Test Points

Nominal	Lower	Upper
101	90	110
120	104	128
202	180	220
208	180	220
220	190	235
230	200	244
240	208	256
380	331	407
400	346	422
415	360	443

2. For each output circuit under test, connect the terminals capable of supplying current to the ammeter, voltmeter, wattmeter, and adjustable load using the low resistance test leads.
3. Measure and record open circuit voltage.
4. If overcurrent protection is used, alone or in combination with a regulating network, short-circuit the overcurrent protection.

   If inherently limited power sources (transformer impedance, series impedance, regulating network) are used, skip this step (there is no overcurrent protection to short).

5. Adjust the load to achieve maximum output current. This adjustment may be just before the point of foldback or current limiting or at short circuit.
6. Record maximum available current.
7. Adjust the load to achieve maximum volt-ampere output (the same as maximum wattage since we are using a nonreactive load). This adjustment may require plotting or listing data and additional measurements around the peak to find the maximum value.
8. Record maximum available volt-amperes.
9. If inherently limited sources are used in combination with overcurrent protection, skip this step.

   If an inherently limited source other than transformer impedance or a fixed impedance is used, faults (short or open circuit) are inserted in the regulating network and steps 5 through 8 are repeated.

PASS/FAIL CRITERIA

1. Open circuit voltage (U_{oc} shall not exceed 30 Vac or 60 Vdc).
2. If inherently limited:
   a. Output current in Test Procedure steps 5 and 6 shall not exceed
      8 amps for open circuit voltages up to 30 volts or
      $150/U_{oc}$ amps for open circuit voltages over 30 volts.
   b. Output volt-amperes in Test Procedure steps 7 and 8 shall not exceed
      5 x U_{oc} volt-amps for open circuit voltages up to 20 volts, or
      100 volt-amps for open circuit voltages above 20 volts.
3. If overcurrent protection is used, not in combination with inherently limited sources:
   a. Output current in Test Procedure steps 5 and 6 shall not exceed
      $1000/U_{oc}$ amps.
   b. Output volt-amperes in Test Procedure steps 7 and 8 shall not exceed
      250 volt-amps.
4. Overcurrent protection ratings shall be no more than:

   5 amps for open circuit voltages up to 20 volts,
   $100/U_{oc}$ for open circuit voltages above 20 volts.

44 119-TM-D14: TEST METHOD FOR FLAMMABILITY

PURPOSE

This test method is to establish flammability ratings for combustible materials, allowing controlled or limited fire spread.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, Appendices:

A1 Flammability test for fire enclosures of movable equipment having a total mass exceeding 18 kg and of stationary equipment
A2 Flammability test for fire enclosures of movable equipment having a total mass not exceeding 18 kg
A6 Flammability Tests for Classifying Materials V-0, V-1, or V-2
A7 Flammability test for classifying foamed materials HF-1, HF-2, or HBF
A8 Flammability test for classifying materials HB
A9 Flammability test for classifying materials 5V

TEST EQUIPMENT

- Small circulating air oven/humidity chamber.
- Calcium chloride dessicator.
- Band saw or equivalent for sample preparation.
- Bunsen burner with a wing-tip flame spreader 48 mm wide and a barrel having a bore of 9.5 mm.
- Gas with a heating value of approximately 37 MJ/m^3 (1000 BTU/ft^3).
- Forced draft hood operating to provide adequate ventilation without producing a draft that affects the flame.
- A wire screen holder made from a flat piece of hardware cloth consisting of 0.8 mm steel wires in square mesh 6.5 mm. The flat piece is to measure 75 $\times$ 200 mm with 13 mm at one end bent perpendicular to the remaining 187 mm length.
- A flat 130 mm square of steel wire gauze having approximately 8 openings per centimeter (for Class HB test).
- 50 $\times$ 50 mm swatches of untreated surgical cotton.
- Stop clock or stop watch.
- Two clamps and ring stands.

TEST PROCEDURES

The tests described below are performed by the Material Research Lab (MCESS) in MLO5-1.

Moveable Equipment Exceeding 18 Kg and Stationary Equipment

1. Precondition three samples for seven days (168 hours) in a circulating air oven at a temperature 10 K higher than the maximum temperature reached by the material during test 119-TM-E4 or 70°C, whichever is the higher, and then cool to room temperature.
2. Position the test samples as they would be in actual use.

3. Place a layer of untreated surgical cotton 300 mm below the point of application of the test flame.
4. Apply the test flame to an inside surface of the sample at a location judged to be likely to become ignited. The overall height of the flame is approximately 130 mm and the height of the inner blue cone is approximately 40 mm. For vertical parts, the flame is approximately 20 degrees from the vertical. If ventilation openings are involved, the flame is applied to an edge of an opening; otherwise to a solid surface. In all cases, the tip of the inner blue cone shall be in contact with the surface.

   Apply the flame for 5 seconds and remove it for 5 seconds. Repeat this operation for a total of 5 times in the same location.
5. Repeat steps 2 through 4 on the remaining two samples.
6. If more than one part of the fire enclosure is near a source of ignition, repeat steps 2 through 5 on each sample with the flame applied on a different location.

Moveable Equipment Not Exceeding 18 Kg

1. Precondition three samples for seven days (168 hours) in a circulating air oven at a temperature 10 K higher than the maximum temperature reached by the material during test 119-TM-E4 or 70°C, whichever is the higher, and then cool to room temperature.
2. Position the test samples as they would be in actual use.
3. Apply the test flame to an inside surface of the sample at a location judged to be likely to become ignited. The overall height of the flame is approximately 20 mm with the air inlet ports closed. For vertical parts, the flame is approximately 20 degrees from the vertical. If ventilation openings are involved, the flame is applied to an edge of an opening; otherwise to a solid surface.

   In all cases, the tip of the flame shall be in contact with the sample.

   Apply the flame for 30 seconds and remove it for 60 seconds. Then reapply it to the same location for 30 seconds.
4. Repeat steps 2 and 3 on the remaining two samples.
5. If more than one part of the fire enclosure is near a source of ignition, repeat steps 2 through 5 on each sample with the flame applied on a different location.

Materials to be Classed V-0, V-1, and V-2

1. Cut 10 samples measuring 130 × 13 mm of the smallest thickness used.
2. Precondition five samples for 7 days (168 hours) in a circulating air oven at a temperature of 70 ± 1°C. Immediately afterwards, cool to room temperature for at least four hours in a calcium chloride dessicator.
3. Precondition the other five samples for at least 48 hours at a temperature of 23 ± 2°C at a relative humidity of 50 ± 5%.
4. Arrange the sample with its longitudinal axis vertical and supported by a clamp at its upper end so that its lower end is 300 mm above a flat, horizontal layer of untreated surgical cotton thinned to a maximum freestanding thickness of 6 mm.
5. Support the Bunsen burner with its barrel vertical to enable the burner to be quickly removed from and precisely returned to its position 9.5 mm below the sample.

6. While not in proximity to the sample, ignite and adjust the burner to produce a steady blue flame with an overall height of 20 mm.
7. Move the burner flame into position under the sample for 10 seconds, and then remove it.
8. Counting from the instant of the removal of the burner flame, note and record the duration of any flaming or glowing of the sample. Note if cotton is ignited.
9. Immediately after the flaming of the sample has ceased, again move the burner flame into position under the same sample for 10 seconds, and then remove it.
10. Counting from the instant of the removal of the burner flame, note and record the duration of any flaming or glowing of the sample. Note if cotton is ignited.
11. After positioning the remaining samples per step 4, repeat steps 7 through 10.

Foamed Plastic Materials to be Classed HF-1, HF-2, and HBF

1. Cut 10 samples measuring 150 mm long by 50 mm wide of the smallest thickness used.
2. Precondition five samples (reference A) for 7 days (168 hours) in a circulating air oven at a temperature of 70 ± 1°C. Immediately thereafter allow to cool to room temperature for at least four hours in a calcium chloride dessicator.
3. Precondition the other five samples (reference B) for at least 48 hours at a temperature of 23 ± 2°C at a relative humidity of 50 ± 5%.
4. Support the wire screen holder horizontally approximately 300 millimeters (12 in) above a layer of untreated surgical cotton thinned to a maximum freestanding thickness of 6 mm.
5. Support the Bunsen burner to enable the burner to be quickly removed from and precisely returned to its position 13 millimeters under the bend in the wire screen with the wing-tip parallel to and centered on the bend.
6. While not in proximity to the sample, ignite and adjust the burner to produce a steady blue flame with an overall height of 38 millimeters.
7. Place a sample flat on the wire screen holder so that one end of the sample is in contact with the upturned end of the screen. Samples of combined materials are placed with the foamed plastic side facing up.
8. Move the burner flame into position under the end of the sample for 60 seconds, and then remove it.
9. Counting from the instant of the removal of the burner flame, note and record the duration of any flaming or glowing of the sample. Note if cotton is ignited.
10. Measure and record the length of the sample that flames or glows.
11. Repeat steps 7 through 10 on the remaining samples.

Materials to be Classed HB

1. Cut three samples with smooth edges measuring 130 mm long × 13 mm wide in the thickness used or less.

   For materials used in the application in thicknesses greater than 3 millimeters, the samples shall be reduced to 3 mm thick.
2. Mark each sample across its width with lines located 25 and 100 mm from one end.
3. Precondition the samples for 48 hours at a uniform temperature of 23 ± 2°C and a relative humidity of 50 ± 5%.
4. Support the test sample by a clamp at the end farthest from the 25 mm mark, with the longitudinal axis of the sample horizontal and its transverse axis inclined 45 degrees to the horizontal.
5. Support the flat square of steel wire gauze in a horizontal position 10 mm below the lowest edge of the sample with the free end of the sample even with the edge of the steel-wire gauze.
6. Support the Bunsen burner with its longitudinal axis in the same vertical plane as the lowest edge of the sample inclined at approximately 45 degrees to the vertical, to enable the burner to be quickly removed from and precisely returned to its position with the lower edge of the barrel mouth 10 mm below the free end of the sample, so that the bottom edge of the sample is subjected to the test flame when lit.
7. While not in proximity to the sample, ignite and adjust the burner to produce a steady flame with an overall height of 25 millimeters.
8. Move the burner flame into position at the end of the sample for 30 seconds or until burning reaches the 25 mm mark, whichever occurs first, and then remove it.
9. Time the progress of flaming or glowing from the 25 to the 100 mm mark, or to the point of extinction, if this occurs earlier.
10. Calculate the rate of progress, in millimeters per minute.
11. After positioning the remaining samples per step 4, repeat steps 8 through 10.

Materials to be Classified 5V

1. Either ten samples of the material shall be in the form of test bars 130 mm and 13 mm wide, and shall be the same thickness as the smallest thickness used in the equipment, but not greater than 13 mm, *or*
   eight samples of the material shall be in the form of test plaques 150 mm by 150 mm, and shall be of the same thickness as the minimum thickness used in the design of the equipment, but not greater than 13 mm.
2. Precondition one set of five test bars or four test plaques at least 48 hours at a uniform temperature of 23 ± 2°C and a relative humidity of 50 ± 5%. A further set of five test bars or four test plaques shall be conditioned in a circulating air oven for a duration of 7 days (168 hours) at a uniform temperature 10 K greater than the maximum temperature of the material determined during the test of 119-TM-E4 or 70°C, whichever is the higher, and then cooled in a calcium chloride desiccator for at least 4 hours at room temperature.
3. When test bars are used, the two sets shall be tested.

Each test bar shall be supported from the upper end of the bar with the longtitudinal axis vertical, by a clamp on a ring stand. The burner shall be supported in an inclined plane of a mounting block so that the burner tube may be positioned at a 20 degree angle from the vertical. The narrow edge of the bar shall face the burner. A layer of untreated surgical cotton shall be located 300 mm below the point of application of the test flame.

4. Apply the flame (overall height of the flame is approximately 130 mm and the height of the inner blue cone is approximately 40 mm) to one of the lower corners of the bar at an angle of 20 degrees from the vertical. Touch the tip of the blue cone to the bar for 5 seconds and then remove it for 5 seconds. Repeat this operation for a total of 5 times.
5. After the fifth removal of the test flame, observe and record the following:
    1. Duration of flaming plus glowing
    2. Distance the bar burned or was affected
    3. Whether or not particles dripped from the bar during the test
    4. Any deformation and change in physical strength immediately after burning and when cooled
6. Repeat steps 4 and 5 on the remaining samples
7. When test plaques are used, the two sets shall be tested. Each set of four plaques shall be mounted and tested in a different position so that the test flame is applied as follows. (Overall height of the flame is approximately 130 mm, and the height of the inner blue cone is approximately 40 mm.)
    a. One plaque of each set vertical with the flame applied to the lower corner of the plaque
    b. One plaque of each set vertical with the flame applied to the lower edge of the plaque
    c. One plaque of each set vertical with the flame applied to the center of one side of the plaque
    d. One plaque of each set horizontal with the flame applied to the center of the bottom surface of the plaque
8. Place a layer of untreated surgical cotton 300 mm below the point of the application of the test flame.
9. For the vertical positions, apply the test flame for 5 seconds at an angle of approximately 20 degrees from the vertical with the tip of the blue cone in contact with the test plaque. Then remove the flame for 5 seconds. Repeat this operation for a total of 5 times.
10. After the fifth removal of the test flame, observe and record the following:
    1. Duration of flaming plus glowing
    2. Distance the plaque burned or was affected
    3. Whether or not particles dripped from the plaque during the test
    4. Any deformation and change in physical strength immediately after burning and when cooled

11. Repeat steps 8 through 10 on the remaining samples.

PASS/FAIL CRITERIA

Moveable Equipment Exceeding 18 Kg and Stationary Equipment

a. Flaming drops or particles shall not ignite the surgical cotton.

b. The sample shall not continue to burn for more than 1 minute after the fifth application of the test flame, and shall not be consumed completely.

Moveable Equipment not Exceeding 18 Kg

The sample shall not continue to burn for more than 1 minute after the second application of the test flame, and shall not be consumed completely.

Materials to be Classed V-0, V-1, and V-2

a. The material is of Class V-0 in the thickness tested if all of the following apply.
    1. Combustion of each sample does not exceed 10 seconds after step 8.
    2. Combustion of each sample does not exceed 30 seconds after step 10.
    3. The average duration of flaming does not exceed 5 seconds for each set of five samples.
    4. The material does not continue to burn to the holding clamp, and
    5. The surgical cotton is not ignited by any particles or drops released during or after application of the test flame.

b. The material is of Class V-1 in the thickness tested if all of the following apply.
    1. Combustion of each sample does not exceed 30 seconds after step 8.
    2. Combustion of each sample does not exceed 60 seconds after step 10.
    3. The average duration of flaming does not exceed 25 seconds for each set of five samples.
    4. The material does not continue to burn to the holding clamp, and
    5. The surgical cotton is not ignited by any particles or drops released during or after application of the test flame.

c. The material is of Class V-2 in the thickness tested if all of the following apply.
    1. Combustion of each sample does not exceed 30 seconds after step 8.
    2. Combustion of each sample does not exceed 60 seconds after step 10.
    3. The average duration of flaming does not exceed 25 seconds for each set of five samples.
    4. The material does not continue to burn to the holding clamp;
    5. For Class V-2, ignition of the surgical cotton is permitted to occur.

    If only one of a set of five samples fails to comply with the requirements of Subclauses A6.5, A6.6, A6.9, or A6.10, another set of five samples, subjected to the same conditioning, shall be tested. All samples in this second set shall comply with the appropriate requirements for the material in that thickness to be classified V-0, V-1, or V-2.

Materials to be Classed HF-1, HF-2, HBF

a. The material is of Class HF-1 if, during and after the test:

   1. Not more than one sample reference A and not more than one sample reference B shall flame longer than 2 seconds after removal of the test flame.
   2. No sample shall flame longer than 10 seconds after removal of the test flame.
   3. No sample shall glow longer than 30 seconds after removal of the test flame.
   4. No sample shall flame or glow for a distance greater than 60 mm (2.36 in) from the end to which the test flame was applied.
   5. The cotton is not ignited by any particles or drops released during or after application of the test flame.
   6. A second set of five samples, subjected to the same conditioning, shall be tested if a set of five samples fails to comply with the requirements above, because of one of the following situations.

      a. One sample out of a set of five samples flames for more than 10 seconds; a second sample out of the same set may flame for more than 2 seconds but less than 10 s as permitted, or

      b. Two samples out of a set of five samples flame for more than 2 seconds but less than 10 seconds, or

      c. One sample out of a set of five samples flames or glows for a distance greater than 60 mm from the end to which the test flame was applied, or

      d. One sample out of a set of five samples glows for longer than 30 seconds after removal of the test flame, or

      e. The cotton is ignited by particles or drops released from one sample out of a set of five samples.

      All samples from this second set shall comply with the appropriate requirements for the material of that thickness and density to be classified HF-1.

b. The material is of Class HF-2 if, during and after the test:

   1. Not more than one sample reference A and not more than one sample reference B shall flame longer than 2 seconds after removal of the test flame.
   2. No sample shall flame longer than 10 seconds after removal of the test flame.
   3. No sample shall glow longer than 30 seconds after removal of the test flame.
   4. No sample shall flame or glow for a distance greater than 60 mm from the end to which the test flame was applied.
   5. Ignition of the surgical cotton is permitted to occur.

   A second set of five samples, subjected to the same conditioning, shall be tested if a set of five samples fails to comply with the requirements above because of one of the following situations.

   a. One sample out of a set of five samples flames for more than 10 seconds; a second sample out of the same set may flame for more than 2 seconds but less than 10 seconds as permitted, or

b. Two samples out of a set of five samples flame for more than 2 seconds but less than 10 seconds, or

c. One sample out of a set of five samples flames or glows for a distance greater than 60 mm from the end to which the test flame was applied, or

d. One sample out of a set of five samples glows for longer than 30 seconds after removal of the test flame.

All samples from this second set shall comply with the appropriate requirements in order for the material of that thickness and density to be classified HF-2.

c. The material is of Class HBF if, during and after the test:

1. Not more than one sample reference A and not more than one sample reference B shall flame longer than 2 seconds after removal of the test flame.
2. No sample shall flame longer than 10 seconds after removal of the test flame.
3. No sample shall glow longer than 30 seconds after removal of the test flame.
4. No sample shall flame or glow for a distance greater than 60 mm from the end to which the test flame was applied.

The material is of Class HBF if despite failing to meet the conditions above, all specimens either:

a. Burn at a rate of under 40 mm/min over a 100 mm span, or

b. Cease to burn before reaching 120 mm from the end to which the test flame is applied.

If only one sample from a set of five samples has failed to comply with the requirements above, a second set of five samples, subjected to the same conditioning, shall be tested. All samples from this second set of samples shall comply with the appropriate requirements for the materials of that thickness and density to be classified HBF.

Material to be Classed HB

a. The material is of Class HB provided that no sample has a calculated rate of flaming or glowing:

1. Greater than 40 mm/min for samples of a thickness of 3 mm
2. Greater than 75 mm/min for samples of a thickness of 3 mm
3. That does not reach the 100 mm reference mark

If only one sample of a set of three samples does not comply with these requirements, another set of three samples shall be tested. All samples of this second set shall comply with these requirements for the material in that thickness to be classified HB.

Materials to be Classed 5V

a. Flaming drops or particles shall not ignite the surgical cotton.

b. The samples shall not continue to burn for more than 1 minute after the fifth application of the test flame, and shall not be consumed completely.

   If only one sample in any set fails, the tests shall be repeated on a second set of samples subjected to the same conditioning. All of these samples shall meet the requirements in order to make the appropriate classification.

   If two or more samples of any set fail to meet the requirements, the classification shall not be made.

45 119-TM-D15: TEST METHOD EXTERNAL WIRING OVERLOAD

PURPOSE

This test method is to ensure that faults, erroneous connections, and other sources of overload on operator accessible connectors are incapable of causing fire or injury due to problems with the product or with the overheating of the interconnection cable.

REQUIREMENT

This method tests for compliance to IEC 950 requirements, clause 5.4.6 Abnormal Operating and Fault Conditions.

TEST EQUIPMENT

- Adjustable resistive or programmable load appropriate to fully load the product under test.
- Autotransformer
- Voltmeter
- Ammeter that can measure ac and dc rms current.
- Low resistance test leads.

  12 AWG is sufficient for small signals up to 10 amps.

  For higher currents, use wire rated for at least twice the measured current.
- Adjustable current source, or autotransformer, and isolating step-down transformer.
- Thermocouples and data logger or thermal meter calibrated for 30-AWG iron-constantan thermocouples or equivalent.

TEST PROCEDURE

1. Turn on the product and connect to the worst-case voltage as in Table 30.

Table 30: Supply Voltage Test Points

Nominal	Lower	Upper
101	90	110
120	104	128
202	180	220
208	180	220
220	190	235
230	200	244
240	208	256
380	331	407
400	346	422
415	360	443

2. For each output connector accessible to the operator, connect the terminals capable of supplying current to the ammeter and adjustable load using the low resistance test leads.
3. Adjust the load to achieve maximum output current. This adjustment may be just before the point of foldback or current limiting, 110% of the rating of a protective fuse, circuit breaker, or at the short circuit point for impedance-limited sources.
4. Record the maximum available current.
5. Using the adjustable current source, apply a current equal to or greater than the maximum available current recorded in step 4 to any external interconnecting cable or cord used in this circuit until the wire temperature stabilizes.
6. Record wire part number, gauge, applied current, and maximum temperature and resulting condition of wire insulation.

PASS/FAIL CRITERIA

a. Output wiring shall not show discoloration, softening, flaking, embrittlement, or charring of the insulation.
b. If the failure of the insulation would not result in the exposure to hazardous voltages or hazardous energies, a maximum temperature of 300°C is acceptable.

APPENDIX A REFERENCED DOCUMENTS

A.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-00102-00	*DEC STD 102-0 Environmental Standard for Computers and Peripherals - General Test Requirements*
EL-00119-00	*DEC STD 119-0 Digital Product Safety - Introduction and General Requirements*
EL-00119-01	*DEC STD 119-1 Digital Product Safety - Design Criteria*
EL-00122-00	*DEC STD 122-0 AC Power Line Standard: Design Requirements and Guidelines*
EL-00122-01	*DEC STD 122-1 AC Power Line Standard - Measurement of AC Power Parameters*
EL-00178-03	*DEC STD 178-3 Digital Marking Requirements for Completed Products Intended to be Sold*
EL-00424-00	*Digital Product Safety Handbook*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

A.2 Other Documents

Document Number	Document Title
BS 6301	*Safety Requirements for Apparatus for Connection to British Telecommunications Networks*
CSA 22.2, NO. 950	*Standard for Safety of Information Technology Equipment Including Electrical Business Equipment*
IEC 112	*Method for Determining the Comparative and the Proof Tracking Indices of Solid Insulationg Materials Under Moist Conditions*
IEC 309	*Plugs, Socket Outlets, and Couplers for Individual Purposes*
IEC 664	*Insulation Coordination Within Low Voltage Systems Including Clearances and Creepage Distances for Equipment*
IEC 85	*Recommendation for Classification of Materials for the Insulation of Electrical Machinery and Apparatus in Relation to Their Thermal Stability in Service*
IEC 950	*Standard for Safety of Information Technology Equipment Including Electrical Business Equipment*
UL 1950	*Standard for Safety of Information Technology Equipment Including Electrical Business Equipment*

A.3 Ordering Information

Following are the sources for documents not available from Standards and Methods Control.

- American National Standards Institute (ANSI),
  1430 Broadway, New York, NY 10018,
  Telephone (212) 354-3300 x479
- Canadian Standards Association (CSA), Standards Sales,
  178 Rexdale,
  Ontario, Canada M9W1R3,
  Telephone (416) 744-4044
- CCITT documents: International Telecommunications Union, Secretariat CCITT,
  Place Des Nations CH - 1211
  Geneve 20, Switzerland
  Tel. +41 22 99 51 11, Telex 421000 (UIT CH)
- Underwriters Laboratories (UL), Publications Stock,
  33 Pfingsten Road, Northbrook, IL 60062,
  Telephone (312) 272-8800, x2612 or x2622

APPENDIX B RELATED DOCUMENTS

B.1 Other Documents

Document Number	Document Title
21 CFR 1040	*Federal Regulations*
IEC 252	*AC Motor Capacitors*
IEC 320	*Appliance Couplers for Household and Similar General Purposes*
IEC 85	*Recommendation for Classification of Materials for the Insulation of Electrical Machinery and Apparatus in Relation to Their Thermak Stability in Service*
UL 1446	*Standard for Insulating Systems - General*
UL 519	*Standard for Impedance-Protected Motors*
UL 547	*Standard for Thermal Protection for Electric Motors*
UL 94	*Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Applicances*
UL 969	*Standard for Marking and Labeling Systems*

B.2 Ordering Information

Following are the sources for documents not available from Standards and Methods Control.

- ANSI, IEC, and ISO Documents
  American National Standards Institute (ANSI),
  1430 Broadway, New York, NY 10018
  Telephone (212) 354-3300 x479
- Canadian Standards Association (CSA), Standards Sales,
  178 Rexdale,
  Ontario, Canada M9W1R3
  Telephone (416) 744-4044
- Underwriters Laboratories, Inc. (UL), Publications Stock,
  33 Pfingsten Road, Northbrook, IL 60062
  Telephone (312) 272-8800, x2612 or x2622

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